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Taking measurements for plating from a hull model

"LAYING DOWN" A SHIP [See page 164]

Problems of the Pacific*

Future Commercial Policy in View of Past History

By Professor R. F. Irvine, M. A., University of Sydney

The speaker stated that his object was to give them an idea of the great forces which were gathering in and around the Pacific, and to inquire how these forces were likely to re-act upon Australia, Canada, and the whole British Empire, and what adjustments they would have to make in view of those forces. The many problems that arose were not merely of local or passing interest. They involved the profoundest issues not only for nations, but for the whole of human kind. Clearly, therefore, he could not in one address do more than direct their attention to a few of the more important of those problems.

First a word about the Pacific itself. As they knew, it was the greatest of all oceans, being one and one-third times the size of the whole of the land surface, and in parts studded with islands; but there were great deserts of water, where for thousands of miles the navigator meets no sign of land. Now the glamour of romance—and tropical romance, too—had perhaps tended to make them over-estimate the importance of the myriads of islands in the Pacific Ocean. Their trade—and trade was the world's measure of importance, a very rough measure, no doubt—was as yet comparatively small. The only islands that produced a large quantity of freight were Hawaii in the North, Fiji and New Caledonia in the South, and, of course, the larger island groups like Japan, the Philippines, and New Zealand, which lay on the edges of the Pacific. But the rivalry of nations for their possession has been exceedingly keen. The reason was two-fold. In the first place, these tropical lands were rich, and could be made enormously richer, in products essential either to the food or manufactures of countries in the temperate zones. In the second place, States which have a large world interest, recognize the need of having coaling or store depots in the line of trade routes, or at important strategical points. It was evident also that to countries abutting on the Pacific, sentinel islands were of supreme importance from the point of view of defence. But with those qualifications, we might say that the principal forces with which we shall have to deal have their origin not so much in the Pacific itself as in the countries bordering it, and even in remote countries like the Central Powers of Europe, which at present have no Pacific possession, but which have a definite scheme of world aggrandisement, which includes the Pacific as its ultimate goal.

Now the Pacific Ocean has not only the greatest extent of all the oceans; it has also the longest human past; a thing that we do not quite always realize. Thousands of years ago—long before the great Western nations of today, long before even Greek or Roman were heard of—there were more or less advanced civilizations on both sides of the Pacific. China, for example, had grown into a stable Mongolian Kingdom perhaps four thousand years before the beginning of our era. A Chinese author of today wrote: "There is no existing nation in the world that has a larger past than China. She has seen the rise and fall of the ancient Egyptian dynasties; the extension of the Persian Empire; the conquests of Alexander; the irresistible advance of the Roman legions; the deluge of the Teutonic hordes from the north; and the birth of all the nations of modern Europe."

The Japanese also, a people compounded of various elements, but chiefly Mongolian and Malayan, stood at the beginning of our era on a high plane of civilization, and even then exhibited the excleatic tendencies and the adaptiveness which distinguish them today.

Then away to the east in Central and South Africa, civilizations waxed and waned, reaching their highest development in the Aztec and Incan Empires, the latter of which was an extremely interesting example of despotic socialism.

In the meantime, successive waves of people driven from the mainland of Asia by the pressure of other races, swarmed into the islands. The existence of megalithic buildings and monuments in various parts of the Pacific, suggested that before the arrival of the black and brown peoples who at present occupied these islands, there existed great barbarian empires in the Pacific itself. Whence these people came; what manner of men they were; how or why they disappeared; whether through some vast convulsions like the sinking of a continent, or by extermination by some unknown maritime people, all of these were as yet unanswered enigmas of the Pacific.

*Notes of a lecture reported in the *N. S. W. Railway and Tramway Magazine.*

In that remote past there were continual wanderings, continual collisions, and fusions of people. The south-eastern parts of Asia, with the adjoining islands, were, as they still are, a vast meltingpot for races, languages and cultures, as well as the starting point for fresh migrations of people. The impelling forces were hunger, loot and fear. Those had always been the impelling forces in great ethnic movements. Alone of all the peoples of eastern Asia, the Chinese and Japanese have maintained their identity through the years, and probably they were destined to play a much more important part in the future. They might, indeed, prove an important factor in enabling the western peoples to determine the present war in favor of liberty and justice.

When, at the beginning of the 16th century, Balboa first beheld the waters of the Pacific from a "peak in Darien," and claimed them for the King of Castile, Europe was in entire ignorance of the vast ethnic movements which had been taking place in and around the great sea. No authentic traveller had as yet penetrated the mystery which still brooded over its countless islands and the great island-continent of the south. All that Europe knew, even of long-established civilizations like those of China and Japan, was confined to the tales, not always truthful, of adventurers like Marco Polo. But it was by these tales of strange lands and wealth beyond dreams that the imagination of Europe was set on fire. It was this fabled East that became the loadstar of western adventure and cupidity.

From then onwards—from the beginning of the 16th century—the Pacific was attacked in two ways, namely:—

(1) By maritime expedition by way of the Cape of Good Hope or Cape Horn, and

(2) By the movements of European colonists and conquistadors across to America; and during the last century, by the advance of Russia through Siberia.

The coming of the Europeans was a fascinating story, but it was too long for him to tell that night. He could give only a few details which might serve to reinforce the cumulative impression he was seeking to make.

Those who came by sea were adventurers who here and there established trading posts or "factories," for in the beginning there was nothing like a migration. The Portuguese were the first of these skirmishers from Europe. Then came the Spaniards, at that time at the height of their national pride, and daring explorers and conquerors. In 1560 they began the conquest of the Philippines. Towards the end of the 16th century the Dutch came on the scene, and then the English at the beginning of the 17th century.

These were the actors in the first act of the new drama of the Pacific. It was a trial of strength and aptitude for trade and empire among the people of Europe themselves. In this struggle the Portuguese were the first to succumb. Attacked by Dutch and Spaniards they lost all their settlements except Timor and Macao on the coast of China. During the 17th century the Dutch were in the ascendants. Spain continued to hold the Philippines, but her grasp had become feeble. The latter part of the 18th century saw the waning of the Dutch and the rise of English power in the Pacific. Cook hoisted the British flag in Australia, and India was in process of complete subjugation. In the several settlements which followed the Napoleonic wars, Holland received back her East Indian Empire. But by the colonization of Australia and New Zealand, by the founding or capture of strategic points like Singapore (1819) and Hong Kong (1843), and by the extension of their influence in further India and the Malay States, the British people for the time became the controlling influence in the Pacific. Although from time to time, groups of islands have been annexed, it cannot be said that this influence has been aggressive; on the contrary, during the past hundred years it has been primarily directed to the establishment of peace and order throughout the Pacific.

In the meantime, Spaniards and Portuguese, mingling their blood with aboriginal races, had become masters of Central and South America, Aztec and Incan civilizations fell easy victims to small bands of European marauders armed with guns. Out of those conquests came the Latin America of today. It was now divided into many republics, of unequal development, long troubled by anarchy, and still by problems of indiscriminate race mixture. There were, however, progressive States, whose organization had greatly improved. Such were the Argentine, Brazil, Chili, Peru, Bolivia, and Uruguay. All observers agree that those countries possess economic resources, and their people an energy which would yield them brilliant results. They must no longer be compared with the turbulent States of fifty years ago. They are, in fact, vigorous and progressive nations. In South America the Latin and Iberian peoples of Europe have found a new home, and are building up a new and better civilization.

The story of how, in North America, the Anglo-Saxons and French pushed their pioneer settlements across the continent to the shores of the Pacific was sufficiently familiar to everyone.

The mere reference to these things served to bring into prominence a fact of capital importance. By the middle of the last century the world had been full-circled. East and West were once more face to face; the arena, however, was no longer the steppes of Russia or the uplands of Iran, but the broad island-strewn waters of the Pacific. By 1860 peoples of European race and civilization had firmly established themselves in North and South America, in Australia and New Zealand, in many island groups, in India, and the Malay States, and in the far north. Russia, pushing eastward, had reached the Pacific, and made contact with China and Japan.

The final phases of the great world-drama were so important and so pertinent to this (Professor Irvine's) purpose, that he would have to deal a little more fully with them. They began in the late "seventies" and early "eighties" of the last century. They presented old characters transformed and new characters inspired by barbarian ambitions, and soon to plunge the whole world into a more hideous Armageddon than that of which the Seer of Patmos dreamed.

Among the momentous happenings of that later period were the following:—

(1) The awakening of Japan, her adoption of Western culture and science, and her rise, within a single generation, to the position of a great world power.

(2) The sudden outburst of megalomania on the part of some Western nations, led on by that upstart and bully of the modern world, Germany. The parcelling out of the world's unoccupied spaces, and of countries occupied by inferior peoples had already gone far. Late in arriving, and full of envy and malice, Germany was determined to bluff or fight her way to world domination. So far as the Pacific was concerned, her attention was first directed to those islands which lay at the very door of Australia. They had now clear reasons for believing that that choice was part of an elaborate scheme, a preparation for the day when she should be able to tear limb from limb the great commonwealth of free nations, which composed the British Empire. One of her objectives was, and still is Australia. The fate of Australia and the Pacific was not the least of the issues now being determined on the blood-soaked plains of Flanders and France.

A few men here and elsewhere saw through the mask and rightly gauged the true character of Germany's colonial ambitions. They agitated for the annexation of all but the Dutch part of New Guinea. But the British Government of those days was averse to further territorial expansion, and was sincerely desirous not to play the part of dog in the manger. It was not until Germany, in 1884, had declared a protectorate over the north-eastern part of the island and over various adjoining islands that the British Government was induced to sanction a British protectorate over the remaining part of New Guinea. It was noteworthy that, in yielding to the wishes of Australia, the Imperial Government adhered to the old policy of retaining in its own hands the control over colored races. In 1901, on the creation of the Commonwealth, a change was made, and Australia for the first time undertook the management of a dependency and the control of native races other than its own.

This appearance of Germany in the Pacific forced not only the British Government, but other Governments to adopt a more active policy of expansion. Within the next decade and a half practically the whole of the Pacific Islands were divided among Western nations—Great Britain, Germany, France, and the United States. The latter country, after considerable hesitation, annexed Hawaii in 1898. At the close of the war with Spain, America found itself in possession of the Philippines and Guam, the largest of the Marianne Islands. Later, by the convention of Samoa, she ac-

quired the island of Tutuila with the magnificent harbor of Pango Pango.

Many people in the United States were opposed to these annexations. It was contrary to traditional policy, a policy, however, which originated in days when it was thought that even a great state could lead an isolated existence and ignore any responsibility for, or interest in, the wider community of mankind. But in spite of sentimental objections, America has been obliged to abandon the letter, and a good deal of the spirit of the early policy.

There is, however, a marked difference between the expansion of the Anglo-Saxon peoples and that of the Germans. The former were not aggressive in a political and military sense; they did not seek to subjugate long established and civilized states. Their development had been the result of trading, of wars thrust upon them, of the instinct of self-protection, and of the necessity to maintain order among unorganized peoples.

The Germans, on the other hand, make their bid for Empire as a carefully-thought-out national policy aiming at world domination. Their expansion had been political and military from the start. Their trade followed the wake of the flag and the guidance of the mailed fist. They did not hesitate to attack, and try to assimilate peoples quite their equals in civilization.

(3) The third feature of the later period had been the unseemly scramble to gain advantage in China. There, too, Germany forced the pace; but she was not wholly to blame; the real inspiration was to be found in the riduculous European assumption that the Chinese were an inferior and uncivilized people, and so might be treated as persons in the game of European aggrandisement. Undoubtedly their political weakness under an alien Manchu dynasty, and their failure to follow the example of Japan in arming themselves with Western knowledge and weapons encouraged the wolves to assemble at the gates. Only the jealousies of the wolves and the growing power of Japan saved China from complete disintegration.

A further event of great significance was the coming of Russia to the Pacific. Her main object was to reach the open sea and secure a warm-water port; but that was not unmixed with a desire to share in the plunder of a dismembered China. Had the diplomacy of the Prussianized bureaucrats shown more moderation, the Russia-Japanese war might never have taken place, and Russia might still be enjoying the "lease in perpetuity" of Port Arthur. Her defeat at the hands of Japan put an end, for the time being, to any dream she might have had to supremacy in Eastern Asia. Her recent collapse as an organized nation had in all probability made her a negligible factor in world politics for many years to come, except as anvil for the nation that could best play the part of hammer.

The victory of Japan produced a totally new situation in the Far East, a situation which the changing drama of the great war modified almost from day to day. Japan was now the first naval and military power in the Pacific, and in the mind of many people there remained a doubt whether she would use her advantage with wisdom and moderation, or whether she would use it to gain an exclusive and predominant economic and political position in China, and the Central Pacific.

For the moment, the turbulent power of Germany had gone from the Pacific, but there was no doubt that she would strain every nerve to win back what she had lost. The defeat of the Allies would give her the lordship of the Pacific and of the world. If the tide of battle ultimately flowed against her in Western Europe, she would still have the means of return to the Pacific by way of a broken Russia or by the absorption of Holland and the Dutch East Indies. One had only to state these possibilities to realize how absolutely vital to the peace and liberty of the world was the complete destruction of Germany as a military autocracy. Though Australia was remote from the scenes of horror being enacted in Europe and Western Asia, her fate was, as he had already stated, practically dependent on the issue of that struggle.

Such in large outline had been the story of the Pacific. Looking backwards and reviewing the vicissitudes of the past, one could not fail to be reminded of that dynamic view of history which "sees mankind in a constant flux, racial streams flowing this way and that in great migrations through the centuries" and at frequent intervals, clashing inevitably in deadly struggles for survival. The colossal struggle in which they were now engaged seemed a warning to them that brute force and violence were far from having been eliminated as factors in human evolution.

Cost of Carriage of Passengers in Ships

The gross dead-weight capacity of a merchant vessel is the total weight that can be carried at her maximum load draught. It really represents the difference between the total displacement of the ship and her light-weight.

The light-weight is usually considered to be made up of the weight of the hull proper, including all the steel and iron, the wood and outfit, and the machinery with steam up. The wood weight includes carpenters' and joiners' work, and the outfit includes derricks, auxiliary machinery, galley fittings, and generally all fittings which are carried in the ship permanently. As a rule, the weight of the ship's stores is not included in the weight of the light ship. A number of items go to make up the dead-weight of a vessel, including the weight of fuel, whether coal or oil, the fresh water carried for drinking and washing purposes, the salt water for sanitary purposes, the fresh water for reserve feed, all stores, and the passengers and crew, together with the luggage of the former and equipment of the latter.

The cargo weight includes cargo of all kinds, whether it be general, refrigerated, or special, such as mails or bullion. In a purely cargo ship, as would be expected, the cargo weight forms a very large proportion of the total dead-weight. No weight, of course, is required for passengers and their equipment, and very little for the other items mentioned above as making up the total load. The carriage of passengers in a vessel considerably reduces the weight available for cargo for several reasons. In the first place, a passenger ship requires to be run at a higher speed than a purely cargo vessel. In consequence the under-water portion of the ship is made finer in order that this higher speed may be easily obtained. This reduces the total displacement, and although the weight of the hull itself is somewhat reduced on account of the fineness of the form it is not reduced in anything like the same proportion as the displacement. Although the lines are fined to obtain the higher speed, the power required is still greater than it would be in a cargo ship of similar size, so that the machinery is much heavier. Further, a good deal of weight is required not only for the passenger fittings, such as cabins, public rooms, galleys, etc., but also by extra passenger decks and boat accommodation. The larger crew that must be carried to serve the passengers requires accommodation also, and the power necessary to supply the numerous wants of the passengers must be provided by extra auxiliary machinery.

Thus the carriage of passengers is responsible for a very large increase of weight, making the light-weight of the vessel much greater than it would be in a ship of similar size carrying cargo only. Further, not only is the total dead-weight considerably reduced by this decreased displacement and additional weight in the passenger vessel, but very large inroads are made into it, still, by the requirements of the passengers. The powerful machinery consumes a large amount of fuel, for which accordingly a great deal of weight has to be allowed; because, although the trip will be made in quicker time, on account of the increased speed of the passenger vessel the consumption of fuel for the same distance will be much greater. The requirements of the passengers have to be catered for by the provision of fresh water and consumable stores, and in addition more reserve feed water must be carried. The result is that the cargo dead-weight is very small.

The differences between two similar vessels, one carrying no passengers and the other a fairly large number, are clearly shown in the following table:—

—	Cargo Ship.	Passenger Ship.
Length	420ft.	420ft.
Number of Passengers	—	600
Speed	11½ knots	15 knots
Load—Total	8,300 tons	4,770 tons
Coal	600 "	900 "
Feed water	50 "	100 "
Fresh water	50 "	350 "
Passengers and baggage	—	75 "
Crew and effects	10 "	15 "
Stores	50 "	150 "
Cargo	7,540 "	3,180 "
Cu. ft. per ton of cargo	60	50

It might be thought that on account of the small weight available for cargo the passenger vessel would have more relative space available for cargo than the cargo vessel herself. This, however, does not always prove to be the case. The lines of the former vessel being finer, the holds are really of much less capacity for the same length. The more powerful machinery takes up more space in the ship, still further reducing the capacity, and in addition the passengers have to be accommodated on decks which would, in the cargo vessel, be used for cargo. Expressing the matter as cubic feet per ton of cargo, and considering the two vessels mentioned above, the cargo ship would have space equivalent to 60 cu. ft. for every ton of cargo that could be carried while in the passenger ship the figure would be 50. The result is that it is often difficult to load passenger vessels down to their maximum draughts, certainly more difficult than with cargo ships.

These considerations show how necessary it is at the present time to build ships particularly for cargo carrying. They incidentally bring out the very great reduction in cargo capacity caused by higher speeds, and indicate the disadvantage of giving mercantile vessels speeds high enough to enable them to evade German submarines.—*London Times Engineering Supplement.*

Small Weights on Big Scales

It is occasionally desired to weigh small articles accurately when the only means available is a platform scale designed for weighing hundreds of pounds. By a method outlined herewith, small articles may be weighed on platform scales within 1/100 lb. and often within 1/400 lb. of accuracy.

On most platform scales the 100-lb. weight actually weighs one pound. That is, one pound on the weight pan will balance 100 lb. on the platform. Other scales have ratios of 200:1 or 50:1. In any case the ratio can usually be found easily by reading the marks on one of the weights or weighing one or more of them.

Let us assume we have a platform scale capable of weighing up to 600 lb. by half-pounds and that it has a ratio of 100:1. If it is desired to weigh a small article accurately, place it on the weight pan and run the sliding weight back to zero. Then put sufficient weight of any kind on the platform to raise the beam. Your own weight is usually most convenient. Balance the scales with the sliding weight, and note the reading. Suppose this to be 115½ lb., for example; then remove the article being weighed, say it is a spring, and again balance the scales by sliding the weight on the beam or adding scale weights to the weight pan. Note the reading again, say 153 lb. The weight of the article is $(153-115\frac{1}{2})\div 100=0.375$ lb.

This method can be extended to cover many uses, as for any weight from as small as will tip the beam up to a weight as great as the range of the scale divided by the ratio.

One particular use of this method is for the determination of specific gravity. If we have a specimen of metal, rock or other insoluble substance that will not float, the following method may be used: With a light cord hang the specimen a foot or so below the weight pan and take its weight. Then hold a pail of water so that the specimen is submerged and weigh again. Using the rule, specific gravity equals weight in air divided by loss of weight in water, if a piece of metal weighs 1.43 lb. in the air and 1.225 lb. in water, the specific gravity is $1.43\div(1.43-1.225)=6.97+$.

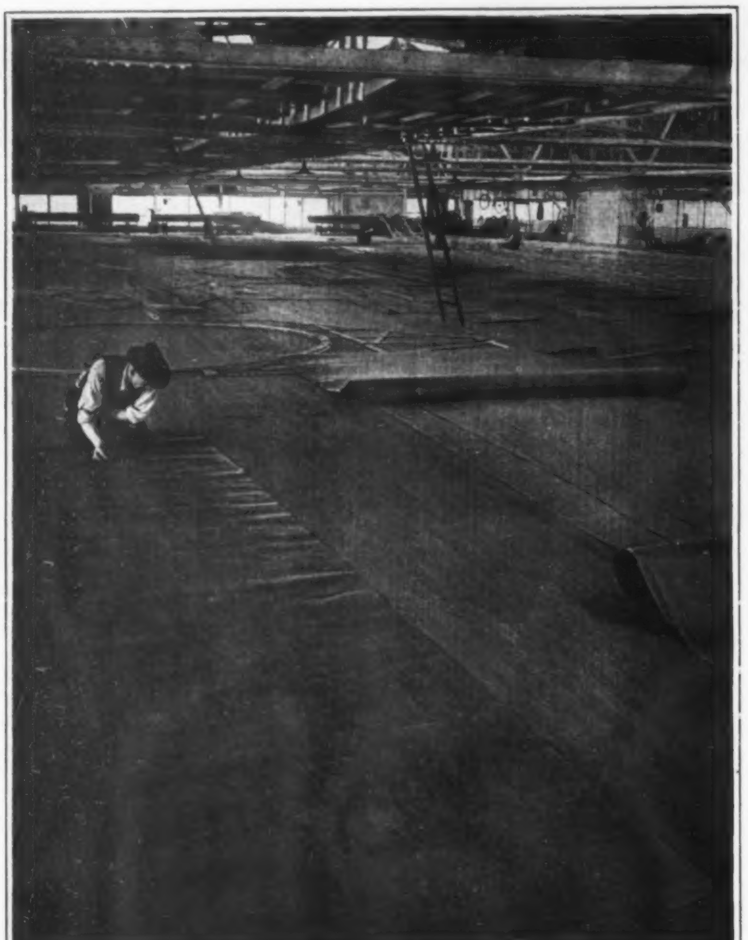
In the case of liquids hang an empty bottle on the scale pan by a cord and balance the scales. Then fill the bottle to a given point with water and find the weight of the water by the method already given. Then fill the bottle to exactly the same point with the liquid to be tested and get the weight of that. The specific gravity of the liquid will be equal to the weight of liquid divided by the weight of water. That is, if the water weighed 2.147 lb. and the weight of an equal volume of a certain kind of oil was 2.042 lb., the specific gravity of the oil would be $2.042\div 2.147=0.952$.

The idea of using the ratio of the scales applies also to utilizing the scales for counting when the amount of counting to be done does not warrant a special scale. Suppose we have a thousand or so nuts to be counted. Place a box on the scale platform and balance the scales by the sliding weight. Then put the nuts into the box. Again balance the scales by piling nuts on the weight pan. If the ratio of the scales is 100:1, there will be as many hundreds of nuts in the box as there are nuts on the pan. If accuracy is desired, the final balancing may be done by taking a few nuts out of the box and counting the odd nuts and those on the pan by hand.

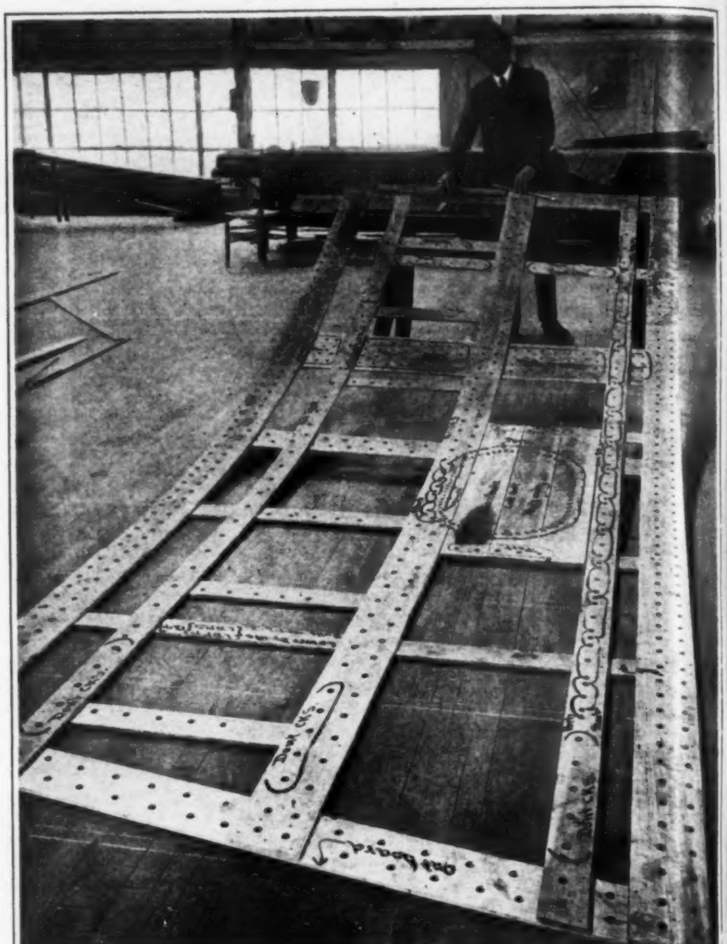
When there is much counting to be done, it will be found handy to make a special pan out of a small pie tin and a piece of rod to take the place of the regular pan. It should be made to weigh exactly the same as the regular pan and will hold many more small parts. Such an arrangement will be found handy in any storeroom and will usually pave the way for a regular counting scale.—M. D. Church in *Power*.

Deck Sheathing

In shipbuilding, one of the effects of wood shortage is the increased use of substitutes for sheathing on steel decks. The chief drawback of some of these compositions, particularly those in which sawdust is bound together in a stone-like mass, is that they retain a quantity of chloride of magnesium which, in solution, is powerfully corrosive to steel, and may accumulate between the composition and the steel deck.—*The Engineer.*



Developing side plating from drawings to indicate proper curves in the finished plate



Template for a steel side plate, with all rivet holes accurately located

"Laying Down" a Ship

The building of a ship is a decidedly complicated operation, and, in many respects, is very different from the processes followed in any other mechanical structure. To start with it is decided what the capacity of the vessel shall be to perform the particular service required, and then estimates are made of the dimensions necessary to produce that size. Elaborate drawings are then made that show the form as accurately as possible, and here is where one of the striking peculiarities of the work manifests itself; for, when preparing drawings for a machine, or for a building, it is comparatively easy to show the exact shape desired, this is quite difficult in the case of the ship, owing to the complicated combinations of curves involved; and, moreover, owing to the great difference between the size of the drawings that it is practical to make when designing a ship and the actual structure, exact measurements cannot be made from the drawings with any great certainty. In this short description only the general form of the vessel is considered, and not the structural details.

The dimensions being decided on, the first step is to prepare a profile drawing, which shows a general elevation, distinctly indicating the outline as seen from one side. Upon this profile view are drawn the waterlines, as many as may be deemed desirable, which appear as a series of horizontal lines, and a base line, drawn parallel to the principal waterline, and a short distance below the elevation of the keel. Then a series of vertical lines are drawn to indicate the positions at which cross sections are to be drawn. The "body plan" is then drawn, which consists of a series of cross sections of the hull at the points indicated by the vertical cross section lines of the profile view. As the two sides of the vessel must be exactly alike, it is only necessary to draw the cross sections for one-half of the hull; and it is customary to draw in the sections from the midship section to the stern on one side of a central vertical line, and those from midships to the bow on the other side of the central line. The next drawing to be made is the half-breadth waterline view, which is done by laying off a center line, and the cross section lines, located at the same points as indicated in the profile plan, and laying off on these section lines the distances indicated on the body plan at each waterline between the center line and the section line indicating the shape of the hull. A flexible batten is then bent to intersect the points thus obtained, which gives the shape of the vessel at each waterline, each of these lines indicating the shape of the hull at the corresponding horizontal sections. Two other series of section lines are now drawn on the body plan, one set being drawn vertically at suitable distances from the center line, termed "bow and buttock" lines; and the other series is drawn from the center line diagonally downward to intersect the curves of the body section lines at the most important points of the curve. These are the "diagonals." The bow and buttock lines are now laid out on the profile view, and the diagonals on the half-breadth plan; or as is usually most convenient, to avoid a complication of lines, the diagonals are drawn on the opposite side of the center line from the half-breadth waterline plan. It will be seen from this brief description that we now have four series of sections of the hull, each series being cut in a different direction, as well as the profile, which is a central, longitudinal vertical section.

As has been pointed out, owing to the small scale to which these drawings on paper can be made, it is not possible to get all of the numerous measurements exactly accurate; and if they were it is not possible to take off these measurements from the drawings with sufficient accuracy. It is therefore necessary, in order to get the correct shape of the various frame members for construction purposes, to reproduce all of these drawings enlarged to the full size of the actual ship. This is done in the mold loft, and is what is technically known as "laying off." The mold loft is an immense floor, smooth and of closely laid hard wood, which is longer than the actual ship to be built, and wider than the full depth of the hull from the lowest point of the keel to the highest point of the rail. Frequently this floor is left in the natural wood, but it is sometimes painted a dull black, or white, in order to show the lines, which are drawn on it in different colored chalks to distinguish the different drawings, more clearly.

The same drawings are laid out on this floor that were drawn on paper, and this is done by carefully measuring from the base and center lines the distances to the points of intersection of the various section lines, and then drawing in the lines through these points. In drawing in the various curves with battens, which are long, flexible strips of wood, of clear straight grain that will bend to a true curve without kinks, it will be found that humps or hollows will appear at some places if the batten is forced to coinicide with every point marked. It is therefore necessary to "fair" the lines; and this is usually done by springing the batten through as many of the points of the buttock and diagonals as can be done and secure a clean, fair curve, and comparing the points that are out with the lines of the other drawings to determine where alterations should be made so that the intersection points on all of the drawings will coincide—for this is absolutely necessary both for construction purposes and to produce a hull that is fair and free from irregularities. And it may be said that this process of fairing requires a thorough understanding of the design, good judgment and long experience.

After all the lines are properly faired and accurately drawn in, the next step is to prepare templates, molds and patterns from which the builders shape the frames and other parts of the structure of the hull, which are of the full size of the various parts, and on which all rivet holes and other details are accurately indicated. These templates are built up of strips of light boards which are cut out to correspond in outline with the lines drawn on the floor, and tacked together, as shown in the accompanying illustrations, which are taken in a loft where steel ships are being built; but the same procedure is followed in wooden shipbuilding. Frequently an accurate model of the hull of the vessel is also made, and this greatly facilitates the work of laying out the sizes and shapes of the plating of steel ships, and the planking of wooden ships. The actual work of building the ship follows general well known mechanical methods.

It will be understood that the above is only a general outline indicating the methods employed, a detailed description of which would be too long and complicated for the general reader.

On the next page will be found a set of the principal drawings for a ship design, such as are referred to above.

Damascene Steel

Damascene steel, which may contain from 1.1 to 1.8 per cent carbon, is prepared in three ways: (1) by the old Indian method in a crucible from pure ore and charcoal; (2) by the Persian method from pure soft iron and graphite; (3) by a heat treatment like a very prolonged tempering. The characteristic "watering" is referred to the original austenite dendrites distorted by the forming. Very slow cooling in the furnace from fusion gives a coarse crystallization and a "milky way" of cementite globules. The spheroidal cementite comes from the slow cooling, or in the third process from the breakup of cementite cell walls and streaks at a very dull red heat. It is to this type of occurrence of the cementite that the remarkable ductile and elastic behavior of this steel is ascribed. It is necessary that the forging should not be carried out at a temperature above the dullest red.—*Note in Jour. Soc. Chem. Ind.* on a paper by N. Belaiew before the Iron and Steel Inst.

Restoring Books and Papers Injured by Fire

Constructing templates from full-size drawings on the mold loft floor

Any one who has tried to burn books or packages of old letters has observed that the task is rather difficult. When the outer leaves are charred they present a considerable degree of resistance to the passage of the heat to the interior, so that the inner leaves are apt to be merely browned. Even on the leaves completely charred, the written or printed characters can commonly be discerned, because of the composition of the ink. However, the action of the fire has produced such an extreme frailty of the fiber, that it takes but little handling to reduce the charred pages to a hopeless mass of dust. But modern science has discovered methods of "reconstituting" and preserving even such fragile tissues, whether the burned documents be composed of parchment with script and illumination in ancient inks, or of paper covered with characters in printer's ink. Among the earliest scholars to study the question was Sir Humphrey Davy, apropos of certain papyrus discovered at Herculaneum and Pompeii. In 1824 Messrs. Forshall and Madden succeeded in restoring nearly a hundred parchments belonging to the Sir Robert Cotton collection in the British Museum which had suffered seriously in the great fire of 1731. Likewise in 1880 a German scientist made a valuable report upon the subject. But the modern development of this delicate art is probably most indebted to a professor of chemistry at the University of Turin, Dr. Icilio Guareschi, who was given the task of restoring the ancient manuscripts charred in the fire of January 25, 1904, which partly destroyed the Biblioteca Nazionale of that city.

The terrible ravages by fire in Belgium and France during the past few years have emphasized the importance of this art. The formulae of Dr. Guareschi are being employed in restoring some of the MSS. injured in the incendiary fire of the University of Louvain as well as the communal archives of various cities in the devastated regions, and other papers of historical or legal importance.

The delicate technique of these processes is described in *Je Sais Tout* (Paris) by M. Francis Marre, the chemical expert attached to the Court of Assizes and Tribunal of the Seine at Paris, and it should be of peculiar interest in America, where the number and extent of our fires so seriously exceeds those in the countries of Europe in other than war times. We read:

"The problem raised by the vandalism of the Boches on the subject of the restoring of public or private archives attacked by fire is therefore at once more complex and more simple than it would seem at first blush. It varies according to whether it concerns the ancient MSS. of museums or modern official documents. In the first case there must be exclusively reconstitution for conservation, while in the other it suffices to reconstitute for photographing."

M. Marre informs us that bundles of parchments must be handled differently from books or bundles of papers. When the shriveled pages of the latter are sprinkled with water they may be carefully flattened into their primitive form and dimensions, which they will retain after being dried, and as we have said, the inner pages will no doubt be protected partially by the charred outer leaves. In packages of parchments, on the contrary, the heat easily penetrates the interior.

"Moreover, if the parchment, after being heated to a temperature of about 250° C., is abruptly sprinkled with water before becoming entirely cold, it contracts in irremediable fashion, and its surface is diminished by about two-thirds. The leaves thus excessively deformed and shriveled up remain absolutely indecipherable.

"This is due to their essential nature. While our modern papers are made from a cellulose pulp suitably manipulated and dried, parchment is made from the skin of the sheep or lamb, and vellum from that of still-born calves. The fresh skins, after being stripped of wool, are treated with lime, then stretched on frames and dried slowly in the shade. They are afterwards scraped and pumiced, but not tanned nor curried. Hence they are partially transformed into gelatine under the action of heat, at the same time undergoing a sort of distillation which causes their surfaces to exude a veritable animal tar which speedily unites the superposed leaves into a blackened block, completely shriveled and almost vitrified.

"The first step, therefore, is to put this block in a closed oven where it is kept in prolonged contact with steam at a low temperature, which slowly brings about a parting of the leaves. The parted leaves are separated one by one, cleaned with the utmost care by means of a fine sponge saturated with warm water to which a little formalin has been added, then gently stretched in every direction. These operations must be conducted, too, with the nicest possible care to avoid diluting the ink of the text or the colors of the illuminations by an excess of water.

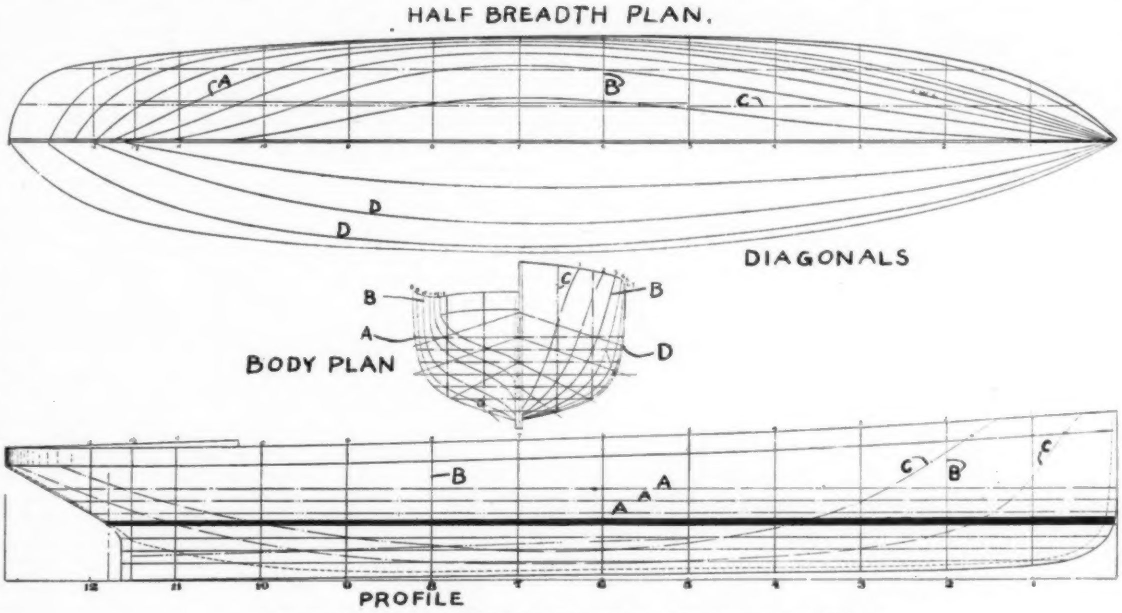
"When this is accomplished the sheets are plunged into weakly alkaline baths of potassium acetate or potassic soap (of one per cent); by this time they have recovered almost all of their original flexibility and may be stretched anew until they return almost fully to their original dimensions. Finally the treatment is ended after suitable bathings and dryings, by a truly artistic operation, which consists of tracing the characters or drawings with a brush dipped in certain solutions, tannin or ammonium sulfide, to revive the colors and render the legibility as perfect as possible."

M. Marre next takes up the question of restoring legal documents, etc., sufficiently to procure photographic copies of them, and recites the case of a merchant in a little city of Lorraine who fled before the tide of war, after having placed his valuable papers on an iron strong-box which he hid in one of his cellar walls, sealing the cavity with mortar. After the battle of the Marne he returned home but found, to his chagrin, that his house was a mass of blackened ruins and that the contents of his iron box were completely carbonized. He sought the aid of a Paris chemist, by whose skill most of the documents were sufficiently restored to be photographed. Such photographs of course must be examined in connection with the original fragments and passed upon by a court of law in order to establish their legal authenticity.

"A package of papers in an enclosed space submitted to the sufficiently prolonged action of a high temperature, first turns brown, then undergoes an actual distillation, in the course of which it disengages volatile products. The residue consists of superposed sheets more or less shriveled up, and more or less completely transformed into carbon. On the surface of these fragile black sheets the printed characters appear in lighter tones, being at times difficultly visible. If by means of a very soft brush we apply a coat of ricinated collodion (containing castor-oil) to the upper surface of the top sheet, the characters remain visible through the transparent coat. When the collodion is dry the leaf it protects is separated by the blade of a razor from the one beneath it, and the lower surfaces is then similarly coated. Each leaf is then treated and carefully numbered."

If a document be in fragments, these pieces are placed in their proper order between two pieces of glass which are cemented together, and can then be easily handled, preserved and photographed.

The object of the photographing is not merely to secure copies but to render the text more legible, since the collodion or glass plates are rather difficult to read except by a very oblique light.



Specimen of principal drawings for a ship showing shape of the hull
A—water lines; B—cross sections; C—bow and buttock lines; D—diagonals

Photographic Spectra of Meteorites.

Working with a spectrograph specially built for laboratory investigations, having 5 double prisms of right- and left-handed quartz of the Cornu type, and lenses of 40 mm. aperture and 700 mm. focal length, with three interchangeable slits of the fixed-jaw pattern, photographs of the spectra of 30 meteorites have been obtained in the region λ2,500 to λ7,000. To cover this extent of spectrum eight exposures were necessary for each record. Experiments are described having for their object the estimation of the relative amounts of chromium and nickel present in various meteorites, the basis being similarity of relative line intensity when compared with the spectra of laboratory-prepared alloys of known composition.

Although it is true that only approximate estimates are thus made possible, it is suggested that the amount of Cr present was between 0.6 and 0.1 per cent. Detailed tables are given, showing the constituent lines of Ni, Cr, Mg, Si, Na, Mn, K, Al, and Cu, as they occur in the different meteorites.

What appears to us as the most striking fact is their similarity of composition, and the small number of elements represented. Only ten elements are found, and only four of these—Fe, Cr, Mg, and Ni—are present in quantity. With three exceptions the proportions between these elements appear to be the same in all.—Note in Science Abstracts on a paper by W. Crookes in *Roy. Soc. Phil. Trans.*

Modern Aeronautics—III*

A Review of Some Outstanding Problems

By Dr. W. F. Durand

[Concluded from Scientific American Supplement, No. 2227, Page 151, September 7, 1918]

If we have tarried so long over these phases of the problem of the airscrew propeller, present methods of design, etc., it is in order to bring into clearer relief the parts of the problem which are not yet well in hand—the parts which *are* as yet outstanding and awaiting our further study.

These phases which thus stand out represent in effect the lack of an adequate correlation between the three methods of approach as above described.

It is obvious that if we could develop an adequate and reliable correlation between the results of the computation according to method No. 1 and the final test under flying conditions according to No. 3—if, in other words, we could adequately determine the error of No. 1 and hence the correction to be applied in any given case, then a pencil and pad of paper would go a long way towards furnishing the material for the solution of the problem of airscrew design, once that we are permitted, of course, to assume a definite set of operative conditions.

Or again, if we could know more accurately and more widely, the character and amount of error to be anticipated in the use of the small models according to method No. 2, we should be in a position to use the experimented model method with better assurance of definite and reliable results for the full-sized screw later to be constructed.

It seems likely that this final correlation of computation with ultimate result may best be made in two stages. The first should comprise a careful study of the relation between the results derived by the computations of method No. 1 and the model tests of method No. 2. Such a correlation would then permit us to pass readily from the results by computation to the probable results by model.

The second correlation should then comprise a series of comparative tests to determine with sufficient generality of application, the character and amount of correction to be applied to the results of model test in order satisfactorily to reproduce the results to be expected from full-sized forms.

This would, by no means, require the testing of a full-sized form corresponding to each model. If so, there would, of course, be no use in making model tests. The whole program might as well be carried out directly by tests on full-sized forms. It appears reasonable to expect, however, that a well selected and not too numerous series of tests, properly distibuted among the various characteristics of form and of operation, would serve adequately to give the correlation desired.

With such correlations established, we should then have two methods, Nos. 1 and 2, available for the design of airscrews. No. 1 available with no more than a pencil and pad of paper (once the standard section coefficients determined), and No. 2, by model, ready to supply a vast amount of detailed information regarding operation under varying conditions, and which may be realized rapidly and effectively once the model is made.

If we have spent so much time over these matters relating to the airscrew, it is because of its importance as an element in aerial navigation, and in order that we may the better note just what part of the general problem is still outstanding.

This, as we have seen, lies primarily in the matter of the correlation between the three methods outlined. There is indeed need for continuing experimental research, especially on systematically selected forms, both model and full size; and such continuing experimental work combined with carefully directed studies of correlation will go far toward giving us an assured and adequate basis for the practical solution of the airscrew problem as applied to aerial navigation.

Reaction Between Airscrew and Plane

Perhaps the widest and most important outstanding problem in connection with aeroplane propulsion has relation to the reaction between the plane and the propeller—the influence of the structures adjacent to the propeller on its performance, economic and otherwise, and the influence of the propeller on the plane, both as regards its lift and its net resistance to propulsion. This is a field which is largely outstanding. It must be attacked chiefly by the experimental method—by model with results checked up by comparison with full scale trials so far as practicable. Time forbids more than the mention of this promising and largely uncultivated field of aerodynamic investigation.

*From *The Aeronautical Journal*.

Multiple Airscrews on One Shaft

Of a closely related nature is the problem of the interaction of two or more airscrews on one shaft. This is a problem which is becoming of importance in connection with the increase in power of aeroplane power plants and with the fitting or more than one airscrew on the same shaft.

This likewise is a problem which must be approached experimentally—again through model research checked up by comparison with full scale tests. A beginning has been made on this important and interesting problem and we may expect, in a not distant future, to find it brought within limits of control similar to those surrounding the problem of the individual airscrew.

Airscrew with Adjustable Pitch

In addition to these problems which relate to aeroplane propulsion in its general aspects, and more especially when for the sake of simplicity we assume that the aeroplane remains under a uniform regimen as regards external conditions, there arises a problem of very great present importance, that of some form of adjustment in the technical characteristics of the aeroplane—propeller combination permitting it to be made responsive to variations in the regimen of operation, as for example, change in the density of the air due to change in altitude, or change of regimen required for climbing flight as compared with horizontal flight.

In connection with the prime mover, mention was made of the very important problem of maintaining power at altitude in spite of the decrease in the density of the air. In reality this problem is very intimately bound up with another of scarcely less importance, that of devising means for effectively using such power for propulsive purposes. Without attempting any technical discussion of the question, it will be apparent that the whole problem of the operation of the airscrew as a means for absorbing the power of the prime mover and converting it into the propulsion of the plane will depend on the density of the medium in which and on which it operates. Again, in climbing flight a part of the weight of the aeroplane is carried by the pull or thrust of the airscrew. In horizontal flight it is all borne by the planes (assuming the airscrew shaft then horizontal). Hence, the pull or thrust of an airscrew and indeed its whole regimen of operation may vary widely according as the plane is climbing or flying horizontally. It thus seems reasonable to conclude that for the best results there should be provided some mode of adjustment or compensation so that the airscrew, as it finds itself operating in a medium of continuously decreasing density, or as it finds itself called upon for varying amounts of thrust or pull with varying angles of climbing flight, may be correspondingly adjusted in order to give continuously the best results.

The problem is further complicated by the fact that the aeroplane itself needs a correlative adjustment. As we have already seen, the one factor in aerial flight which remains sensibly constant under all conditions and at all altitudes of flight is the weight of the plane and its equipment. The vertical supporting force gained from the reaction of the air must therefore be maintained constantly equal to this weight at least for the conditions of horizontal flight, while for climbing flight the weight will be divided and borne partly by the supporting planes and partly by the airscrew. The problem of the economic use of power at varying altitudes and under varying angles of climbing flight involves therefore the following chief elements:

- The weight of the plane.
- The surface of the wings and their aerodynamic characteristics.
- The angle of attack of the wings.
- The speed.
- The power developed by the engine.
- The revolutions of the airscrew.
- The area and form of the blades of the ariscrew.
- The pitch of the airscrew.

These various factors react and interact in a most complex manner and any attempt to discuss the problem in detail would carry us too far afield on the present occasion. Reference has already been made to the problem of wing surfaces, adjustable either in area or form. Such adjustments are, however, not yet available and at present the angle of attack is the one feature about the plane which may readily be carried. On the other hand there is no feature of the propulsive agent, the ordinary airscrew, which admits of equally simple correlative variation. What is needed with regard to the airscrew is, indeed, some means of realizing an adjustment correlative to the change in the angle of attack for the plane. To this end a change of pitch is most suitable, some means of varying, at the will of the pilot, the pitch of the screw in order that with the fixed diameter and area of surface, and with the work available per revolution of the engine as affected by the density of the air, the pitch may be so adjusted as to secure the number of revolutions best adapted to the economic use of the power given out by the prime mover. This will then ensure the thrust needed to overcome the resistance of the plane at the angle of attack and speed which, taken conjointly, will give the lifting force needed to support the weight of the plane, either in whole or in part, according as the plane is flying horizontally or climbing.

All of this somewhat complicated statement means simply that what is wanted is an airscrew with blades adjustable for pitch. Such an airscrew may be realized by so pivoting the blades that they may be turned about a radial axis, thus changing their angle relative to the axis of the screw itself. Extreme changes of such a character result in a very wide variation of pitch from root to tip and in the end will result in a serious loss in efficiency. There are therefore two problems involved:

(1) The aerodynamic problem of determining the best form and proportions of an airscrew, the blades of which are intended to be pivotable in this manner, so that under the widely changing conditions of flight which may be met with, there may be effective operation and a well sustained efficiency.

(2) The mechanical problem of so designing and building an airscrew with adjustable blades that it will meet the rigorous requirements imposed upon it by the exacting conditions of aeroplane navigation.

It is perhaps not too much to say that the first problem is already well in hand. We know reasonably well what forms and proportions to give to such an airscrew, and if it were only a matter of design or of the determination of form and proportion, the problem could hardly be called outstanding.

As much cannot be said regarding the second problem. The practical construction of an airscrew with adjustable blades is not an easy matter. Several modes of construction have been attempted, but with only moderate success. The problem is clearly defined, of the highest order of importance, and is outstanding as one of the appliances for which the art of aerial navigation is definitely in waiting.

Stability and Control

The three fundamental requisites of an aeroplane are strength, movement and stability with control. We have noted some of the problems arising under the requirements of strength, and movement or propulsion. We may now turn very briefly to glance at the situation regarding stability and control. Any detailed discussion of these problems would be quite out of the question on the present occasion, and time in any event will only allow us a brief glance at the general situation.

Regarding stability and control it is not too much to say that the general principles underlying these characteristics of an aeroplane are now reasonably well understood, due largely to the splendid theoretical and experimental investigations initiated by British scientists and to which certain workers in the same field in the United States may have contributed something, and by no means overlooking certain important contributions by French and Italian investigators. These investigators, both analytical and experimental, have placed the study of these subjects on a reasonably sure foundation, and have served to mark out the way to secure any desired degree of stability which may be desired or which may be consistent with other valuable qualities. We are here confronted with one of those situations, so frequently encountered in scientific and technical work, where a choice must be accepted on some middle ground between wide extremes, and where the attempt to secure some desirable quality in high degree may lead to a limitation of desirable qualities in other directions.

So it is with stability and control. If stability is carried to an extreme then mobility and quickness of maneuvering are reduced and control in the sense of ready response is lacking. For military purposes, especially for machines of the fighting type where mobility is of the highest importance, this would be a serious short-

coming, and hence such machines cannot be given too much stability in the ordinary sense of the term. On the other hand, for heavy machines of the bombing type, where mobility of evolution is not so vitally important, the margin of stability may be greater. Going to a still further extreme, it is perfectly easy to build a safe moderate speed family carriage sort of machine which will be stable and secure, under almost any conditions likely to develop. Such machines would be scorned by fighting pilots, but when civil aeronautics begins to come into its own after the war and under peace conditions, and there comes a demand for safe machines for civil purposes, including family outings for the week-end from the city to the country or to the sea coast, then we may anticipate a larger recognition of the qualities making for safety and stability, and we shall find machines provided having such characteristics and in practically any desired degree. Here again, however, there will be degrees of choice, because it will be found that with too high a degree of stability, what may be termed the riding qualities of the plane will be poor, while with low stability the riding qualities may be much smoother.

The general problem is therefore pretty well solved so far as the ground work is concerned. This does not mean, however, that there is nothing further for us to learn in this connection. There are many problems of a detailed nature inviting the student of this fascinating field of study and the solution of which will serve to round out and broaden our general grasp of the subject. In particular, we need further study on the interaction between elements which ensure stability and those which permit mobility and readiness of response to control agencies, to the end that we may control more effectively the combinations which may be desired regarding stability and mobility of evolution.

Again, while the elements of control are well understood, there is room for further study as to the best means of actually developing the control forces required and of applying them to the plane itself. These are partly aerodynamic and partly structural problems, each phase reacting more or less on the other.

One instance of problems of this character will serve to illustrate the type.

Thus, we know that an aeroplane is provided with rudder surfaces of two kinds, one to determine movement in a vertical direction, up or down, and the other to determine horizontal motion, right or left. But these motions, vertical and horizontal, assume that the plane itself is horizontal or sensibly so. However, when a plane is circling on a steep spiral or making a quick turn, it is inclined or "banked," in order to avoid side slipping, until, in extreme cases, the wings are nearly vertical, and frequently much more nearly vertical than horizontal. In such cases, the functions of these control services are reversed. Those which, with normal aspects, serve to produce movement right and left will serve to determine motion rather in a vertical direction, and those which formerly served for movement up and down will now serve to determine motion to the right or left. For intermediate angles of bank, each set of control surfaces will give control forces in both directions, up or down and right or left.

Now, it is by no means sure, having in view this double and interchanging function between these two sets of surfaces, whether we have as yet realized the ultimate and best arrangement either as regards the surfaces themselves or their control by the pilot.

It seems decidedly probable that we have not and that some arrangement yet remains to be devised which will be more effective in the matter of this double and interchanging function of control, and simpler in its relation to the pilot.

This and other like problems are still awaiting investigation and offer a delightfully promising field for the further study of the aerodynamic engineer.

ARMAMENT AND INSTRUMENTS

There still remain two large and important fields, rich in aeronautic problems. These are armament and instruments. I shall attempt no more than the briefest general reference to these two classes of problems.

Those arising under the head of armament are, of course, strictly military in character and but little of interest could, in any event, be said in a public address. Such problems relate naturally to the number, type, and size of guns to be carried, their mounting and special sights; bombs and devices for carrying, aiming, dropping, etc.; questions of armor and protection of vital parts against gunfire or sharpnel bursts, etc.

Expressed in their most general terms these problems resolve themselves into an attempt all along the line to meet the requirements imposed by the desired military uses of the plane, and to anticipate or improve upon the devices and designs of the enemy in the same fields.

Regarding instruments, little more specific can be said. This field does, however, bristle with problems of the highest interest to the scientist, and may well challenge his best efforts. It is interesting to note the extent to which the modern aeroplane has become a flying meteorological and physical laboratory. Thus, a recent list of aeroplane instruments shows some 25 or 30 different instruments and devices, not indeed all to be carried on one plane, but all included in the general aeronautic military programme, and each serving some specific and important purpose.

With these instruments as with armament, the problems reduce themselves to an effort to meet the military or the navigational and operative requirements of the situation, and in these days of war in particular, to anticipate or improve upon the similar devices and designs of the enemy.

Much of the work relating to these problems under armament and instruments is already done and well done. There do remain, however, many problems, especially of detail or of improvement, and they must be considered as outstanding; but of these I shall attempt no mention or discussion.

By way of conclusion, reference may, for a moment, be made to a problem of the most vital and far-reaching economic importance, and which will be upon us with the arrival of peace conditions. This is the problem of the best economic utilization of the enormous investment which has been made in aeronautic production, expressed in terms of money and human time and energy, and now represented by factories, machinery and equipment, finished product, trained industrial organizations, human skill and productive capacity.

The discussion of such a problem might well occupy our careful attention for the entire hour, but I can no more than mention it here by name. We can, however, scarcely over-exaggerate its importance, and the appointment of important commissions in England and in the United States for the study of the problems arising under this general head is an evidence that their serious import is appreciated, and we may hopefully await suitable measures of adjustment against the day when we may again turn our thoughts to the occupations of peace.

And so with all our problems; we can only look hopefully forward for the future to give to us such measure of answer as our patience and study may merit.

Of one thing, however, we may be sure, and that is that the day will never come when we have no more problems to solve. But, on the contrary, the number of problems still outstanding, as the years go by, is likely, rather, to increase with our acquaintance with the subject, and we may be sure that before this or any like audience under the auspices of the Aeronatuical Society of Great Britain, there will never lack material for a discussion of "Outstanding Problems in Aeronautics."

A New Method of Creosoting Lumber

A NEW method of creosoting Douglas fir piling and lumber has recently been developed by Professor Bror L. Grondal of the College of Forestry of the University of Washington. The new process is designed for the creosoting of air seasoned material only, and promises to save a considerable amount of material that is rejected under standard specifications when treated by the methods ordinarily employed in the treatment of this class of material. The old and commonly used method consists in immersing the air seasoned lumber or piling in hot creosote for ten to fifteen hours until the wood has reached a fairly uniform temperature of about 200 degrees Fahrenheit. Creosote is then forced into the wood by means of hydraulic pressure until the required penetration of creosote into the wood has been obtained. The pressure period usually extends over a period of from three to eight hours, so that the time required for the treatment of an entire charge of average material will usually be in the neighborhood of twenty hours. As a result of the preliminary hot bath in creosote oil, the season checks, which are inevitably obtained in air seasoning Douglas fir piling and large timbers are opened up, and all pitch seams and other defects are greatly increased, with a consequent loss of material that fails to pass the rigid inspection that is now demanded by all purchasers of creosoted material.

The new process is startlingly simple. It consists in the elimination of the initial heat treatment and immediately subjecting the piling or lumber to "cold" creosote under long continued high pressure. Experiments made by Professor Grondal in the experimental plant of the College of Forestry, which has been duplicated at one commercial creosoting plant, have given very favorable results, and a number of tests in commercial plants are contemplated. The new process is based on the hypothesis that the preliminary heat treatment in the old method has the effect of casuing the moisture in the wood to come to the surface, as air seasoned material in the larger sizes of timbers usually contains from 20 to 30 per cent of moisture. If this preliminary treatment is continued for a sufficient length of time the wood becomes dry and readily admits the creosote under pressure. When continued for only twelve or fifteen hours there is very little drying effect, as wood is a very poor conductor of heat, and when the creosote is applied under pressure it must move in a direction opposed to the travel of the escaping moisture. In the new method, omitting the preliminary heat treatment, the creosote, which is slightly miscible with water penetrates the wood in a uniform manner, though longer time is required, probably due to the greater viscosity of the creosote at the lower temperature. The "cold" creosote is introduced into the retort at a temperature about 115 degrees Fahrenheit, and is allowed to cool to 10 degrees Fahrenheit. As there is no drying action upon the wood, checks which already exist are not increased, as when at a normal temperature Douglas fir has high compressive strength and will withstand high hydraulic pressures. Hot, moist Douglas fir is, however, relatively plastic and deteriorates under high pressure. Pitch seams are not opened up in the new method, as the cold creosote has only a solvent effect upon the resin in pitch seams, the resin being replaced with creosote. No restrictions are placed upon the use of the new method.—*West Coast Lumberman.*

Norwegian Water Power

IF Norway has been somewhat slow, as far as the State is concerned, in taking up the exploitation of its water-power, the first movement that is being made in that direction is a very important one, and the installation will be one of the largest in Europe. It is in connection with the oft-discussed Nore falls, which, according to the plan now prepared, are calculated to yield some 320,000 horse-power at the generators.

The origin of the combination of rivers and lakes which are able to yield such a large capacity is the Heisantjernet, connected with the lake Nordmandslaagen, about 1,260 miles above the level of the sea. The catchment area of the Nore falls is 1,770 sq. km. This combination of stream and lake has different names in the different sections of its course, but is generally called Laagen. Its volume of water at Tunhövd, from 1906 to 1916, varied from 75.8 per cent to 121.5 per cent on the year, of the normal or rather average volume for these years. The volume of water for a year averaged 1,278,180,000 cu. m. working out at 40.6 cu. m. per second, or 22.9 liters per second per sq. km. of catchment area. In order to obtain the desired storage some nine lakes will be dammed, forming reservoirs of a capacity varying from 32,000,000 to 356,000,000 cu. m. The aggregate storage will amount to 1,040,000,000 cu. m.

The earlier plan for the exploitation of the Nore falls, which were purchased by the Norwegian State some 10 years ago, has been abandoned, and in selecting the final plan two alternatives were considered, both including an upper and a lower power station. The Rödberg alternative has been chosen as possessing the greatest advantages. According to it the upper power station is placed at Rödberg on the Opdal river and the lower at Vrenne on the Norfjord, at the latter of which the Opdal river and the Halland falls, which belong to the State, will be utilized. The river Borge and the lake Oktern have been reckoned with as possible auxiliaries.

For the upper power station there are two inlets, two tunnels of 25 sq. m., two distribution basins, and 12 tube lines in connection with a corresponding number of generating units. For the lower station there is one inlet, one tunnel of 46 sq. m., one distribution basin, and six tube lines and six generators.

The upper station is placed on a plateau of solid rock, and is 160 miles long by 25 miles broad. When fully equipped it will contain 12 units of 21,500 horse-power each. Thus, with one of these in reserve, the power available will be 236,500 horse-power. The net height of fall lies between 342 m. and 324 m. With full load each turbine uses 6 cu. m. per second, and the dimensions of the tunnels are designed for a volume of water of 36 cu. m. per second. At the lower station a tunnel of 46 sq. m. leads to the mountain side at Vrenne, where the distribution basin is located. The length of this tunnel is 3,750 meters. The distribution basin is entirely blasted out of rock, and from it six tube lines, arranged in three tunnels, lead into the open. The tube lines are 139 meters long. The power station, 79 miles long and 22 miles broad, is founded on solid rock, and will contain six units of 16,500 horse-power each; with one in reserve, the available power will thus be 82,500 horse-power. The net height of fall is between 97.5 meters and 92.5 meters. Under full load the turbines consume 16 cubic miles of water per second each.

The cost of the upper power station, when the full capacity is installed, is calculated at 33,580,000 kr. (about $9,000,000), and of the lower station at 14,994,000 kr., ($4,018,000).—Engineering Supplement of the *London Times.*

Photos by the author

A coffee drying plant in Costa Rica. The dried coffee has been raked into large heaps

Side Lights on the Coffee Industry

Facts and Scenes from Central America

By Hamilton M. Wright

"How much coffee are you shipping to the United States," I asked an expert of the Costa Rica Government.

"More than ever before. I can't give you the exact figures but I think this war will have the effect of turning a greater part of our Central coffee crop into the United States," he replied. "During the year 1914-15 we shipped 77.15 per cent of the coffee crop to Great Britain, 14.69 per cent of the coffee crop to the United States, and 1.79 per cent to France which makes a total of 93.63 per cent of the coffee crop shipped to these three countries. The remainder went undoubtedly to the West Indies and Central American republics. The coffee shipped to the United States in 1914 was worth $469,209. The coffee shipped to Great Britain was worth $3,533,895. The coffee shipped to Germany was worth $483,124. Naturally our Great Britain trade has fallen off and our German trade has been reduced to virtually nothing. On the other hand our trade with the United States has increased.

"In 1913 the percentages of our trade were as follows: with the United States 51.44 per cent; with Germany 15.44 per cent; with Great Britain 14.85 per cent. These figures relate to our total trade and not to our coffee trade alone. By 1915 our trade with the United States had risen to 69.18 per cent of our total trade. I think undoubtedly for 1916 it had risen to 75 per cent of our total trade and at the present time is very close to eighty-five per cent of our total trade. For the same year, 1915, our trade with Germany was less than one per cent; our trade with Great Britain was 12.52 per cent. Our total foreign trade has, of course, fallen off. In 1914 it was $18,617,427. In the following year it was $14,450,364. Today it is still less but it shows every prospect of increasing with the United States.

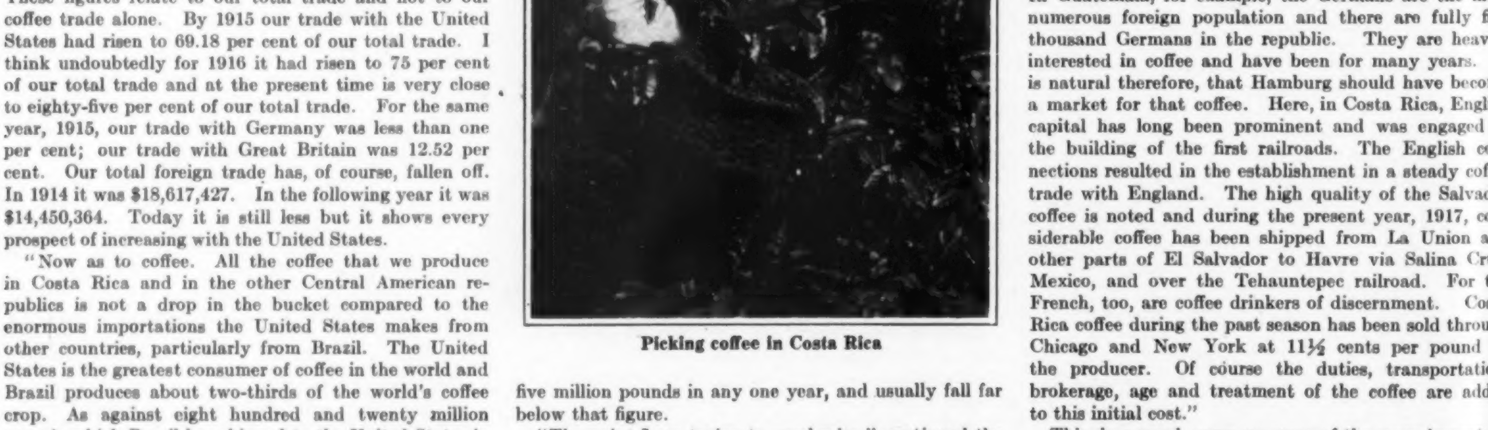
"Now as to coffee. All the coffee that we produce in Costa Rica and in the other Central American republics is not a drop in the bucket compared to the enormous importations the United States makes from other countries, particularly from Brazil. The United States is the greatest consumer of coffee in the world and Brazil produces about two-thirds of the world's coffee crop. As against eight hundred and twenty million pounds which Brazil has shipped to the United States in a single year we ship from Costa Rica from two to four million pounds of coffee on the average. The total shipments of coffee from all the Central American republics to the United States will not exceed thirty-five million pounds in any one year, and usually fall far below that figure.

Picking coffee in Costa Rica

"The point I am trying to emphasize," continued the Costa Rican Expert, "is that the United States which is our nearest consumer, could easily absorb every pound of coffee that we produce. That such a condition would be highly desirable is shown by the fact the present war has greatly curtailed our markets. Our labor conditions and weather conditions remain normal. We therefore have a surplusage of coffee with usually lowered prices and the uncertainties which these create, which would not be the case did our entire shipment go to the States.

"Moreover," he continued, "I do not believe that there are any economical barriers to these shipments. I have heard it said in Guatemala which formerly shipped a great part of its coffee to Hamburg that the States would not pay the prices received in Europe for the same goods. But I do not believe this view to be a correct one. The Americans are the most discerning coffee drinkers in the world, in my opinion, and this is illustrated by the popularity of well-established coffees of known quality. Heretofore the coffee trade in these Central American countries has been largely influenced by the large number of Europeans interested in the industry and in the development of various republics. In Guatemala, for example, the Germans are the most numerous foreign population and there are fully five thousand Germans in the republic. They are heavily interested in coffee and have been for many years. It is natural therefore, that Hamburg should have become a market for that coffee. Here, in Costa Rica, English capital has long been prominent and was engaged in the building of the first railroads. The English connections resulted in the establishment in a steady coffee trade with England. The high quality of the Salvador coffee is noted and during the present year, 1917, considerable coffee has been shipped from La Union and other parts of El Salvador to Havre via Salina Cruz, Mexico, and over the Tehauntepec railroad. For the French, too, are coffee drinkers of discernment. Costa Rica coffee during the past season has been sold through Chicago and New York at 11½ cents per pound to the producer. Of course the duties, transportation, brokerage, age and treatment of the coffee are added to this initial cost."

This, in a word, sums up some of the more important features of the situation as it affects the coffee growers of



A small coffee drying plant, and the husking mill, operated by the family here seen

A coffee district in Guatemala. The trees are retained to shade the young coffee plant

Central America. The war has of course, affected the industry as a whole and in Guatemala a number of coffee growers assured the writer they were in very hard straits but thought the situation was beginning to look better and felt the States would soon be taking the bulk of their product. Of course my readers are familiar with Central American coffee. I dare say there is not one of them who does not know the characteristics of the coffee produced in these neighboring republics. Undoubtedly the grocers are among the best informed of the population as to coffee and their judgment has much to do in directing public taste. I shall not, therefore, expatiate upon the flavor and quality of the product which is well recognized.

Strange it was that although the writer on a recent trip to Central America paid especial attention to the coffee industry he did not recognize his morning coffee when it was placed upon his breakfast table in the city of Antigua. The little Indian waiter girl brought in a pitcher of hot water, a mug of cream, and jar of sugar and asked after some moments did I not wish my coffee. What was my astonishment, after I had replied in the affirmative, when she pointed to a bottle on the center of the table which I had thought was filled with some kind of Worcestershire sauce. In reality the bottle contained a coffee extract. One simply prepared his coffee by removing the stopper and shaking the bottle so that perhaps a tablespoonful was discharged in the cup of boiling water. Cream and sugar were added and the coffee was delicious. This manner of preparing coffee prevails among the Guatemalans.

Permit me to invite the reader to visit with me a modern coffee drying establishment in the city of San Jose, Costa Rica. The finest coffee plant that I saw was located on the outskirts of this beautiful city. San Jose has an elevation of 3,800 feet above sea level. The climate is delightful and it has a progressive white population, many of its inhabitants tracing their ancestry to the proudest blood in Spain. As may be expected the coffee establishment was a model of its kind. To this drying plant growers in the vicinity brought their coffee for handling upon a large scale. The plant covers about four acres and has large concrete surfaces upon which the coffee berries after being husked are spread to dry in the sun. This is a distinct advance over the old method so familiar in our early travel books of drying coffee on mats or even upon the bare ground.

In this plant' as shown in the accompanying photographs the coffee berries on coming from the finca or coffee estate are dumped into a large concrete hopper; are carried by water from the bottom of the hopper to the pulping mill. The mature berries sinking to the bottom of the hopper are carried off by a current of water and borne to the pulping mill where a roughened cylinder revolves closely against a curved iron plate. This removes the pulp of the bean and the membrane which enclosed the seeds themselves. As my readers of course know, coffee on the bush when ripe somewhat resembles a small cherry with two seeds enclosed in a membrane and pulp and facing one another. After the dried pulp of the bean and the membrane which incloses the seed are removed the seeds are borne along by currents of water to graders where they pass between screens of different sized apertures and are thus graded as to size. The berries the different sizes are then borne by currents of water down to concrete drying flats where they are spread beneath the sun's rays. Here the berries are constantly turned so they will be evenly dried. At the big plant at San Jose they are moved by wooden push boards shaped like a rake without prongs. In one of the photographs is shown a pile of coffee as high as a man's head. This however would not be allowed to remain long because the coffee in the center of the pile would ferment.

Coffee in Costa Rica is not usually cultivated at a lesser altitude than fifteen hundred feet above sea level. The preferred elevation is from twenty-five hundred to five thousand feet although you will occasionally find it growing at an elevation of six thousand feet.

In Peru and Ecuador and in some parts of Colombia coffee is occasionally acclimatized at a greater elevation than this. At the extreme low levels both young and old plants require more shade than at the higher levels and the coffee tree does not seem to thrive as well. In its wild state the coffee tree grows from fifteen to twenty feet high. In cultivation, however, it is rarely allowed to become over six or ten feet high. The flowers are small, fragrant and snow white. When the climate is dry abundant irrigation is necessary but the water supply is limited when the fruit begins to ripen and this improves its quality. A coffee tree will yield its first crop in the third year and will keep on bearing for forty years. As the tree continues to flower for eight months its fruits are of uneven ripeness.

When the coffee is ripe the fruit is a dark scarlet color and the seeds are horn like and hard. Many of the finest coffee trees in Central America grow upon the sides or in the vicinity of volcanoes. The coffee tree does best on a gravelly or volcanic soil which is well dried.

Methods of cultivation of coffee differ widely according to the humidity, temperature, and soil of the various regions in which it is grown. In the higher altitudes it is not always customary to shade the adult trees but young trees are usually shaded in whatever altitude they are grown. In Costa Rica and Guatemala non-productive banana plants are sometimes used for shade.

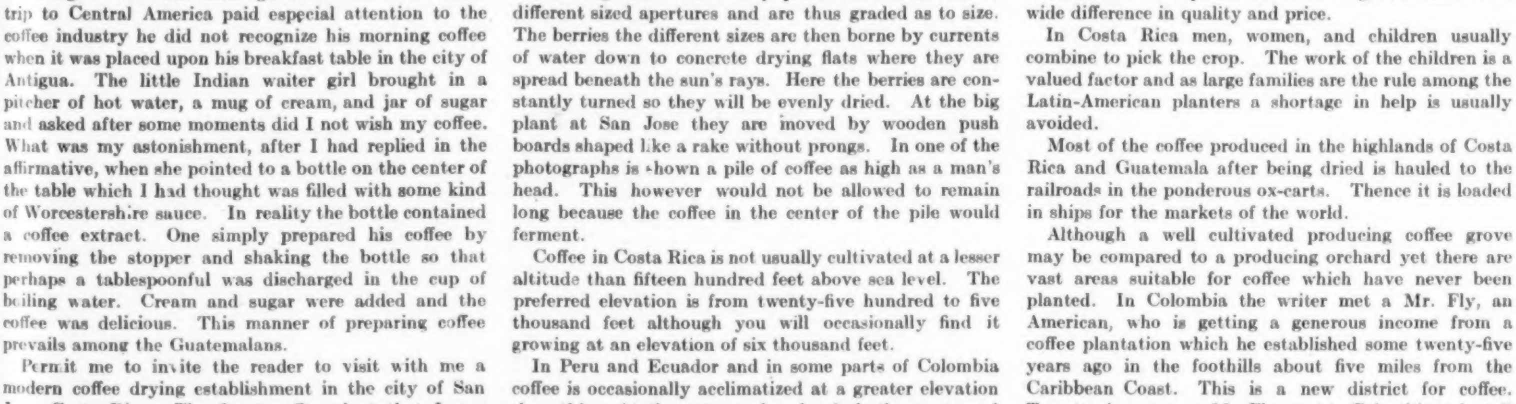
After the coffee has been sun-dried, it is freed from impurities by winnowing and is conveyed in bags to the sea ports. As equal care is not however bestowed upon cultivation in all places where it is grown there is a wide difference in quality and price.

In Costa Rica men, women, and children usually combine to pick the crop. The work of the children is a valued factor and as large families are the rule among the Latin-American planters a shortage in help is usually avoided.

Most of the coffee produced in the highlands of Costa Rica and Guatemala after being dried is hauled to the railroads in the ponderous ox-carts. Thence it is loaded in ships for the markets of the world.

Although a well cultivated producing coffee grove may be compared to a producing orchard yet there are vast areas suitable for coffee which have never been planted. In Colombia the writer met a Mr. Fly, an American, who is getting a generous income from a coffee plantation which he established some twenty-five years ago in the foothills about five miles from the Caribbean Coast. This is a new district for coffee. Twenty-six years ago Mr. Fly went to Colombia to install lighting plants in the cities of Santa Marta and Barranquilla. While on a hunting expedition back of Santa Marta he noticed wild coffee growing abundantly. Accordingly he secured an area of land about fifteen hundred feet above sea level. After three years he concluded he was not high enough and he moved back to the site of his present plantation which is forty-five hundred feet above sea level.

The coffee industry is a fascinating one. The beautiful country in which it is grown, the quaint habits and customs of the people and the cultivation and care bestowed upon the orchard so that each of us may enjoy his morning cup of coffee, lends interest to this important industry in far-away lands.



A great drying plant showing the coffee spread over extensive concrete floors where it is dried in the sun

New Potash Deposits

It is Germany's boast that whatever the outcome of the war she will have the world at her feet economically on account of the potash deposits which she possesses in superior quantity. This threat naturally has redoubled the endeavor in other countries to find other means of supplying this important plant food to agriculturists. Writing in "*La Nature*" Mr. P. Saillor gives the following categorical account of potash deposits available elsewhere.

Upper Alsace[1]—This deposit situated northwest of Mulhouse is one of the most interesting in all respects. When it was described in these pages in 1909 the period of research had just ended and was giving place to the phase of practical exploitation. The results of this practical use I will here set forth briefly without recurring to the geologic constitution or the financial value. Let me merely recall that there have been found at a depth varying from 400 to 600 meters, two layers of potassium salts situated in the Middle Oligocene and separated by 19.5 meters of sterile earth with thick strata of rock salt both above and below; this deposit is far from presenting a horizontal and uniform mass; on the contrary it is marked by irregularity and many folds. The average thickness of the rock salt is 241 meters, that of the upper layer of potassium salt (sylvinite) 1.16 meters and that of the lower stratum 4.14 meters. As shown in the accompanying chart the lower layer of sylvinite surrounds the upper layer throughout its whole extent assuming the form of an ellipse. At the edges the salina strata thins out and disappears. It has been observed that the geothermic temperature varies at different points from 18 meters to 34 meters in depth; at the bottom of the Amélie shaft it is 48° C. A memorandum published in 1912 estimates this upper layer of the sylvinite at ninety-eight millions of cubic meters distributed over eighty-four millions square meters and the lower layer at six hundred and three millions square meters; in round figures this would give (the density being 2.1) 1,500,000 tons of potash salts or three hundred thousand tons of pure potash. The first drilling made at Wittelsheim in 1904 for the purpose of seeking coal deposits resulted in the first discovery of potash; the lead thus given was followed by a campaign of exploration by drilling, which led to the sinking of the first shaft in the Amélie Mine at Wittelsheim. This shaft was finished in 1910 and later fifteen others were sunk.

A short description of the Amélie Mine will give us an idea of the character of the work. The first shaft was sunk by the freezing method and was 600 meters deep. It cost two and one-half million francs ($500,000) and required two years to complete. The first carloads of potash were shipped in January, 1910. The deposit was worked from the north and from the south both strata being put in work at the same time by the method of cross cutting with pilars and stalls. In 1912 the Amélie Mine had a force of two hundred men and the usual output per day about three hundred tons of potassium salt. Thanks to the ease with which it was worked, the yield per man per day ran as high as one and one-half tons. The extraction was made by a continuous current electric motor operated from a central power station. On issuing from the shaft the mineral passed into a mill where it was crushed and ground fine; from there it either went to the potassium chloride works or was shipped directly.

The strata are composed of alternate bands of red and grey consisting principally of the mixture of sylvine (potassium chloride) and of rock salt (sodium chloride). The red bands colored by traces of iron oxide, contain chiefly potassium salts while they grey consist of the sodium salts. There are also found thin veins of argilous schists and of anhydrite. The content of potassium chloride varies generally from 20 to 68 per cent. rarely running below 10 per cent. The minerals are very pure and contain only insignificant quantities of magnesium salts which enables them to be used immediately for agricultural purposes after crushing; this fact also greatly simplifies the chemical purification which is almost elementary in comparison with that required by the carnallite ores of Strassfurt. The principal operation consists in separating the two chlorides of potassium and of sodium by taking advantage of their solubility. The Reichweiler Works (Amélie) is capable of handling two hundred and sixty tons of pure mineral per day with an estimated output of forty to fifty tons of pure potassium chlorides. The content of bromium is slight and is not utilized. Under the German regulations which have been in force at Mulhouse up to the present time potassium has been produced under very strict regulations. According to the law of May 25th, 1910, the Amélie Mine, the only one in Alsace in operation at that time had a right to the insignificant portion of 14.6 in the total production of the Empire *i. e.*, about nine thousand tons of pure potash or forty-five thousand tons of crude potash salts, corresponding to an extraction of fifteen carloads per day, a much lower amount than this center would be capable of.

At the beginning of the war in spite of an improvement in the situation each of the fifteen Alsatian shafts, which ought to have yielded 800 000 tons per year, were permitted to sell only 80,000 tons, and the total amount allotted to Alsace was only one-tenth of the German production.

This situation was necessitated by the need for regulating the German production to agree with world consumption, which it is true was increasing more or less rapidly, but was still much lower than the possible supplies. We can form an idea of this from the fact that 150,000 tons per year are at present sufficient for the entire annual consumption of potash in France; as a consequence, there are certain financial difficulties involved in the necessity of having a considerable amount of capital to supply a restricted sale. The enormous profit per ton (not less than fifteen francs on a sale price of 30 francs) compensates for this however. It is needless to remark upon how these conditions will be modified by the probable return of Alsace to France when the terms of peace shall have been finally agreed upon.

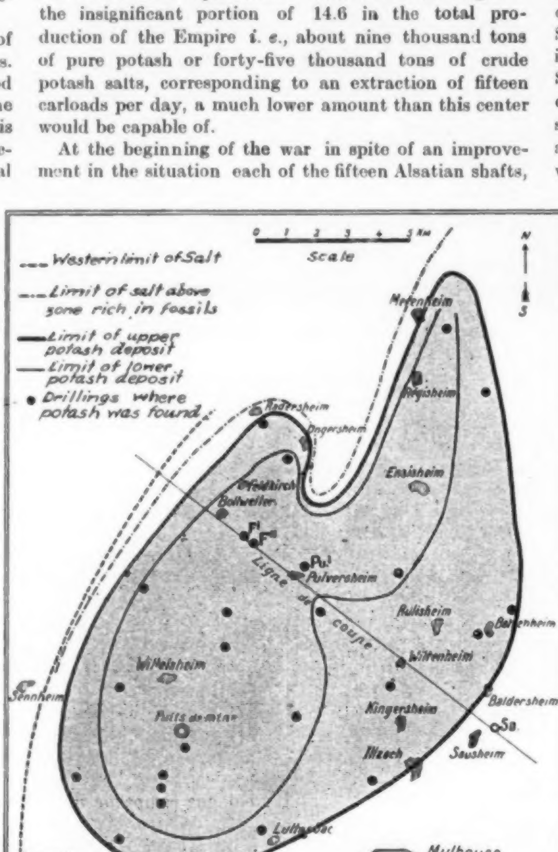
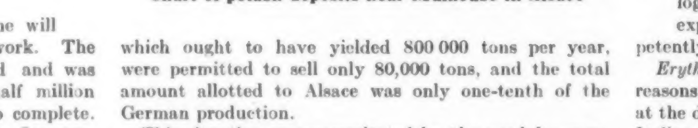


Chart of potash deposits near Mulhouse in Alsace



Section of potash terrain on line indicated on the chart above

Spain, Suria in Catalonia.[2]—This deposit, of which we gave a short account in 1916, attracted much attention before the war. Its discovery is attributed to a Frenchman, M. Macary, who exploited at Suria a layer of rock salt connected with the famous deposits of Cardona, and who ceded his potash concessions to the "Bordelaise Company of Chemical Products." These concessions now belong to the "Société Solvay et Cie." Potash salts are found here at various points between 40 and 60 meters in depth, while others are certain to be found at much greater depths. The deposits, which date from the end of the Eocene or the beginning of the Oligocene, appear to be very much scattered and furnish potassic salts which are irregularly nucleated with the rock salt. This may partially explain why these deposits are still in a period of exploration in spite of the hope that they might be utilized during the war. The mineral consists of carnallite and sylvine, in layers of a deep red color, alternate with rock salt somewhat reddish in tone which covers part white rock salt. The productive zones appear to follow the anticlinal folds, especially from north to south, at Cardona, Suria and Callus. The surface thus far explored, which is only 230,000 square meters, comprises according to Spanish geologists two and one-half million tons of carnallite and one and one-quarter million tons of sylvinite, with a local thickness of 17 meters of carnallite and 3.75 meters of sylvine on the Roumanie Concession, where the first three drillings have been made.

Although we have not been able during the present hostilities to utilize this potash to remedy the deficit caused by the lack of German potash, these deposits must, nevertheless, be considered as coming into future competition with our own at Mulhouse. The Germans, who thoroughly understood this, endeavored in 1914, to get possession of the Spanish deposits in order to keep them non-productive, and it is believed rightly or wrongly that their influence is responsible for the paralysis which these works have apparently suffered from during the last three years, and for a series of legislative restrictions. . . .

Besides the Société Solvay there are two other companies which have obtained concessions and which are now engaged in preliminary prospecting:

1. A company represented and administered by the "Sociedad Anonima Cros.," and by the "Sociedad Electro-Quimica Flix" of Barcelona, which is understood to have connections with the German Syndicate of Strassfurt.

2. Another company which works under the patronage of the "Sociedad de Explosivos," and which has sunk shafts in the neighborhood of the saline deposits of Cardona.

According to current report these two societies have thus far had only unfavorable results. Finally in 1914, a government reserve was decreed in the Communes of Isona, Balaguer, Tarrega, Igualada, Manresa, Vich, and Berga (Provinces of Barcelona and of Lerida). This reserve was to come to an end October 1st, 1916, but it has been prorogued for two years in order to enable the Spanish Geological Institute to proceed with the methodical explorations which it has been actively and competently conducting.

Erythrea.—Since the outbreak of the war, for the reasons above indicated, almost the only potash supplies at the disposal of the Allied Nations have come from the Italian deposits opportunely discovered in Erythrea, 90 kilometers southeast of the Coast of the Massaoua, and 10 meters north of Atel Bad on the fortieth degree. This deposit, situated on the very frontier of the Italian possessions, was at first exceedingly difficult to explore because of the hostility of the Abyssinians. These conditions have now been greatly improved: first, by the more effective taking of possession; secondly, by a recent change of the Government of Abyssinia, bringing into power a party more favorable to the Allies. About 20,000 tons per year are extracted from these mines. According to the rather limited information at hand, this deposit appears to be more recent in date than those of Alsace and Spain, which are tertiary, and obviously still more so than that of Stassfurt, which is Permian. It appears to be the product of the recent evaporation of an ancient arm of the sea, running north-south in a very clearly defined fissure connected with the great lines of fracture which, starting in Palestine, traverse the whole of West Africa along a volcanic line which is still active.

Canoes of East Africa

In the issue of *Man* for April, Dr. A. C. Haddon discusses the outrigger canoe of East Africa. Canoes with outriggers are confined to the Indo-Pacific area, and are absent, and so far as we can tell always have been, from the American continent and Europe. Canoes with single outriggers are unknown in Africa, while canoes with double outriggers are confined to the east coast, from Lamu to Dar-es-Salaam, to the Comoro Islands, and to the north-west coast of Madagascar. Their occurrence in this region is certainly due to a cultural drift from Indonesia, which also brought in its train a peculiar form of fish-trap. Further information, both from East Africa and Indonesia, is required before the question of the origin of this type of canoe can be regarded as definitely settled.

[1]See *La Nature*, 1776, June 8, 1907; 1862, June 30, 1909; 2192, October 2, 1915. *Bull. Soc. Ind.*, Mulhouse, April, 1912 (with detailed sectional chart). Cf. *Nature*, January 25,1913 and 2,187, August 28, 1915; the problem of potash in the United States.

[2]2,237 August 12, 1916, a Spanish Geological Institute has published a recent description of these :Sales Potasicas en Cataluna, by D. Cesar Rubio, D. Augustin Marin (62 p., 3 pl., 1914).

Anthropology as a Corrective of Provincialism*

By John R. Swanton, Bureau of Ethnology

ANTHROPOLOGY is distinctly the study of man in society. It is by its attention to the group or social idea that physical anthropology differs from anatomy and physiology, comparative philology from the mere study of vocal expression and culture history from psychology. And it is apparent that the well being of the individual depends always and in an ever increasing degree upon the well being of the group of which he forms a part and the harmonious relations between himself and that particular group. Of course anthropology is not the only science which considers man primarily as a social being. The same is true of history, sociology, economics and various others. But history, at least that of the older orthodox type, limits itself for the most part to those peoples and those periods of which there are scriptorial records, sciology places its emphasis on mankind in the so-called civilized nations, and economics and similar sciences consider man with particular reference to his material environment or else some special phase of his social relations. In particular it is to be observed that each of these sciences is concerned with the peoples of that one great culture center which beginning in the immediate neighborhood of the eastern Mediterranean gradually spread westward until it came to be represented by the so-called civilized nations of today. Anthropology, considering ethnology and ethnography as subordinate branches, is the only science which professedly and from the very beginning has taken cognizance of all human societies whether they be conventionally called "civilized" or "uncivilized."

The importance of this fact appears when it is known that what we call a civilization has sprung up independently at a number of distinct points or "culture centers" and that no two of these culture centers has consisted of the same elements, has undergone the same institutional or physical development, has enjoyed or suffered from the same environment. Thus the history which each center presents, the expression of its life, the social organization and institutions which have developed within it are different, and the peculiar outlook on life which an inhabitant of any one may happen to have need correction by a study of the outlook of individuals belonging to abler centers. Thus in pre-Columbian North America we find that there was a culture center in the eastern woods, and one on the North Pacific coast, one in the semi-arid Southwest, one, or perhaps, two, in Mexico and Central America, and one in the West Indies. In South America were two or three scattered along the Andean chain and one in the region of Guiana. Turning to the Old World, we are at once arrested by a few well-known culture centers like those of China, India and the eastern Mediterranean, while centers more obscure may be detected in Polynesia and northeast Africa. On examining some of these we note the further interesting fact that they were originally complex, having resulted from the fusion of several originally independent centers. This is true in a way of the center in the eastern woodlands of North America and those on the Andean plateau, but the most conspicuous example of the kind is to be found in that great east Mediterrenean culture center from which our own civilization is descended. This is found to have incorporated a center in the Nile valley, another in the valleys of the Euphrates and Tigris, a third on the island of Crete and probably a fourth in eastern Asia Minor. These facts show that we must not consider culture centers as so many water-tight—or rather influence-tight—compartments having no meaning for one another. On the contrary it is not likely that a single one could be pointed out which had been affected in no degree by at least one other and there is reason to believe that there has never been a time when thought vibrations have not been able to reach all parts of the human race, no people that may be said to have been intellectually sterilized. Each of these centers is to be regarded as the result of a particular running-together or complex of thought waves, a systematization of ideas found in their crude and dissociated condition among all human beings or at least among many more than those constituting the particular center.

At the same time anthropology does not lose sight of or ignore peoples not included in culture centers. Viewed in one way they may be divided up and attached to the several centers as so many parts of a "culture area" since each center influences the most primitive people by whom it is surrounded, but it would probably be truer to consider these primitive or "savage" peoples as comprising the raw material, the people of associated ideas and institutions, out of which the several culture centers have been built, the lowlands of culture from which the centers of civilization project like so many mountain peaks. The subsequent reaction of the culture centers upon them should not obscure the fact of their originally fundamental position.

And now as to the importance of all this for us. We know how, even in the comparatively limited horizon of one nation or one state, individuals tend to assume that to be right and just to which they themselves and their immediate associates are accustomed and that to be wrong which is foreign to their ways of thought. We call such an attitude "provincial," and we laugh at the man from the back township or the mountain country, who thus exhibits his narrow prejudices and the limited mental outlook of the community from which he sprang. But we should be warned that provincialism is relative. One may be "cosmopolitan" as regards countries or towns and make fun of the provincial with only the county or town outlook but be equally provincial himself with relation to views entertained in the next state. Again he may be cosmopolitan as between states but provincial when it comes to another nation, or cosmopolitan as between nations of approximately the same type of civilization but provincial when confronted with nations or peoples of a different cultural or racial type. Even the broadest of us is prone to consider, or rather assume—for such things are often imbedded too deeply in our subconscious natures to be made matters of consideration—that certain ideas, customs, technical processes, forms of government are best, or rather that they are essential, as much part and parcel of humanity as hand or foot or eye, yet we may be absolutely deceiving ourselves. It is the especial function and peculiar privilege of anthropology systematically to study and record ideas, technical processes, customs, and so on whenever found, to the end that mankind may constantly become less provincial, more cosmopolitan in his outlook, may discern more clearly what are the essential accompaniments of human life and human association, what are its nonessentials, also what institutions have been worked out by different peoples and found to benefit, what have been found harmful, what laws seem to be justified by the experience of mankind in other parts of the world and in other periods. In this way anthropology paves the way for a broader outlook on the questions which every culture center, every people, nay every individual, has to face. It renders available as guides, not merely the experience of our immediate ancestors, or related peoples, of our cultural forebears who happened to be possessed of the art of writing, but the experience and experiments of all peoples without any limit other than that set by the boundaries of the globe or the extent to which human memorials have been preserved.

And in the very processes that this study sets at work there is involved a most important corollary. As the more intelligent of all nations seize upon data provided in this manner the cosmopolitanization of thought is certain to extend until mutual toleration and appreciation take the place of mutual repugnance, dislike, and hostility, and much of the psychology that now ultimates itself in war passes away. An obsession that the good of the world requires that its culture shall be all German, or French, or English, or American is but the display on a wider field of the provincialism which holds that it should be patterned on that of Jones county or Smithville. It is an obsession that the prosecution of anthropological studies and the diffusion of the results of such studies are certain to destroy, and I presume that no reasonable human being will, in the light of current history, consider such destruction of other than practical value.

*From *The Journal* of the Washington Academy of Sciences.

Sulpho-Calcic Solution for Grapevine Parasites

TREATMENT of a great number of parasites of grapevines or fruit trees by the sulpho-calcic solution is now becoming prominent in France, Italy and other countries of Europe. Experience has shown the value of this preparation when used alone or together with arsenical compounds, and in Italy it now forms part of current practice. The matter is also being taken up in France, and it is expected to apply it on a large scale before long. The solution, or rather mixture, can be employed against insect parasites which commonly attack grapevines, as well as for fungus growths, and this double action gives it a marked superiority. But in order to act with the best effect against insects, it is essential to add arsenate of lead or arsenate of lime. Again, when mixed with copper sulphate solutions, it gives a very effective action upon the microscopic spore known as ordium, as well as upon mildew. When added to arsenical solution it acts against both mildew and insects. Although there is no secret about the makeup of the sulpho-calcic mixture, it requires some care in preparation, as well as a suitable outfit for the purpose. It is preferable to have it made at special works, such as the one recently started in the south of France, where it can be had at a very reasonable price and is carefully made up in the right proportions, being also in the fresh state or not more than 8 days old, which gives the maximum effect. On the other hand, the French Agriculture Department furnishes the following information.

Composition.—Lime, 8 kilogrammes (17.6 lbs.), sulphur, 16 kilogrammes (35.2 lbs.) water to make up 100 litres of solution (25 gal.)

Outfit.—A boiler having about 100 liters capacity, mounted over a circular flame burner. Three small buckets of reinforced concrete or wood; a stirring paddle and a sieve.

Preparation.—Slack 8 kilog. (17.6 lbs.) of lime (fresh from the kiln), in one of the buckets. Mix up the 16 kilog. of sulphur with water so as to make a soft paste. Pour 60 liters of water (15 gal.) into the boiler and bring to a boil. Mix the slacked lime, 8 kilog. (17.6 lbs.) in the boiling water. When this begins to boil again, and it should be constantly stirred—note the time (when at a strong boil), and commence adding the sulphur, for it is required to take account of the time during which the latter is added. The whole amount of sulphur, 16 kilog. (35.2 lbs.) must be added within 40 minutes. Stir constantly and with care, in order to avoid all deposit of solid matter on the bottom of the vessel. When the time elapsed since the first addition of sulphur reaches 50 minutes, stop the boiling by removing the source of heat, and fill up the boiler with cold water. Use a large dipper to pour the liquid into one of the buckets, straining through a piece of coarse cloth to remove impurities. The solution is then to be put up in carboys.

Use of the Solution.—For insect parasites, add the above to water so as to make up a bath of 8 per cent strength. Higher than this is not to be recommended, for a 10 per cent solution is found to cause burned places on the leaves, especially upon orange trees. For use against oidium, a 3 to 4 per cent solution is used. This latter proportion should be observed when adding the above preparation to the usual copper sulphate bath, for the simultaneous treatment of oidium, mildew and rotting of grapevines, as well as when adding to arsenical solutions.

Time for Treatment.—The time or season, as well as frequency, varies with the nature of the parasites, observing about the same rule as for the ordinary sulphur treatment against oidium or for copper salt against mildew or rotting, or again, for the arsenical mixtures used to treat grapevine or fruit tree parasites. The proportions used in Italy for such solutions differ considerably from what are employed in France, but official tests are now going on in various regions, and it is hoped to bring the matter to a standard before long. It should also be noted that the sulpho-calcic solution has no poisonous effect upon persons engaged in its manufacture or use.

Substitutes for Deficient Metals in Germany

MORE than a quarter of the world's supply of zinc is produced by Germany. According to Schulz commercial refined zinc contains 98 per cent or more of zinc, about 1.3 per cent of lead, and about 0.2 per cent of iron, with some cadmium. It is crystalline in structure and lacks tenacity. Its hardness and strength can be improved by the addition of aluminium or copper, but iron and tin are unsuitable for the purpose. In any case the alloy must contain about 90 per cent of zinc, and not more than 3 per cent of aluminium can be added without the risk of the formation of cavities. A zinc alloy containing about 6 per cent of copper and 3 per cent of aluminium is a suitable material for casting for many purposes, though not for constructional work. For galvanizing with zinc Schoop's process has proved satisfactory. The melted zinc is sprayed by means of compressed air (3½ atmos.) in an atmosphere of coal gas on to the iron, which is heated to 70° to 80° C. Consumption of tin in Germany is 21,500 tons per annum, about 70 per cent of which is lacking, after taking into account the tin recovered from tin-plate waste, etc. For the recovery of this tin treatment with dry chlorine gas has proved the best method, since it converts the tin into chloride, without materially attacking the iron. As a substitute for ordinary solder a mixture of 10 per cent tin, 10 per cent cadmium, and 80 per cent lead is recommended. More recently a cadmium solder containing only 2 per cent of tin and an antimony solder free from tin have been prepared. In 1913 the world's production of aluminium was 78,000 tons, of which Germany produced 15,300 tons. The impurities in the metal, mainly calcium and aluminium oxide have now been reduced to about 0.4 to 0.5 per cent. The copper for electric cables has now been replaced by a steel core round which are twisted 6 aluminium strands. Iron has also taken the place of copper for electro blocks for illustrations, and pyrophoric alloys containing about 30 per cent of iron are used with tinder as substitutes for matches. A saving of leather is effected by the use of steel bands for machinery straps. —*Ber. deuts. Pharm. Ges.*

Wake-Stream and Suction*

An Important Problem in the Navigation of Vessels

By C. H. Holst

THOSE who have gained experience in connection with steamers or power-boats navigating on shallow and narrow waterways, so frequently met with in Holland, are quite familiar with the phenomenon of "suction," a pehnomenon which is seldom experienced when navigating on the open sea.

Masters of canal boats know fully well that when their vessel represents a comparatively large area of midship section as compared with the section of the canal, they have to be very careful to keep the head of their ship in the middle line of the waterway, and that when overtaking another vessel they both do best to slacken their speed, so as to avoid very grave risks of collision or grounding. They also know that when meeting another vessel this risk, although present, exists in a lesser degree.

Boards of canal companies prescribe strict regulation as to certain speeds not being surpassed, so as to protect themselves against damages occurring to the banks of their property, and, generally speaking, inland navigation is the proper school for studying the dreaded symptoms of suction, wash, or how else these inconveniences may be called, which are rarely encountered by sailors.

The views set forth by different people connected with inland navigation differ widely as to the the probable cause of this well-recognized nuisance. Some attribute it to the action of the bow-wave, others to the action of the propellers, others to the irregularity of the canal banks, or to the irregular depth, but, curiously enough, little attention is generally given to the influence of the wake-stream which in the author's opinion is the true and only cause of it.

When studying the phenomenon on board the vessel, it will be found that in front of the ship, if the bow be pretty bluff, a rising of the water-level is to be observed—the finer the bow the shorter the distance in front will be—whereas the water-level shows distinct symptoms of depression near the after-body.

This rising of the water-level is clearly demonstrated as occurring over a pretty wide distance in passing small rowing boats moored to the banks. These appear to be lifted bodily, but without any violent pulling on their moorings. Gradually, as the ship passes the moored boat, it sinks down again, but to a greater depth than the original water-level, which condition is clearly visible if the boat be moored to a small landing platform on the boards of which the regular watermark is indicated by the growth of water plants, and so on.

This sinking sets in as soon as the midship section of the steamer has passed the moored boat, and gradually increases; it is combined with a violent pulling at the moorings and a backward movement, as well as by a movement towards the steamer. Once the steamer has passed, the little boat rises again with the water-level and comes back to its original position. This series is illustrated in Fig. 1.

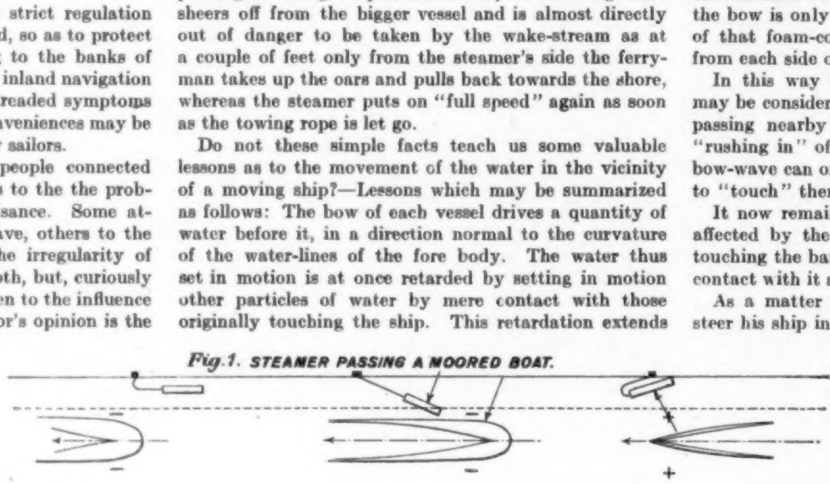
Also when passing parts where the banks are gently sloping into the water and covered with reeds, as is often the case in Dutch canals, the stems of the reeds may be seen being pushed gently towards the bank and the water rising between them, up to about the midship length; and, again abaft the midship section, the water rushes out and the stems incline towards the canal, and floating impurities are swept out from between the reeds and remain in view, until pretty nearly behind the ship everything is restored to peace and to its original place.

Another symptom, but worthy to be noted, is offered by the foam created at the bow of the steamer. On long stretches of perfectly smooth water you may follow the lines of foam and bubbles, forming two exactly parallel lines at a mutual distance of some meters in excess of the width of your steamer, not unlike the wake left behind after the passage of a paddle steamer.

Only in the case of short and bluff boats, principally when bluff at the stern, will it be observed that the lines of foam approach each other near the stern yet very rarely are they found joining into one compact mass unless the propellers of such ships are "churning" the water into an additional width of foam behind the ship.

One more evidence in favor of these views may be furnished by the common practice of ferrymen putting passengers on board of passing steamers at small riverside stations where no regular stops are made. These men row out in small boats up to the middle of the river and await the approaching steamer, keeping their boat head to the tide, but in as near a line as possible with the stem of the steamship. When quite near, the bow-wave pushes the rowing boat gently aside, oars are laid in, and the ferryman taking hold of a rope thrown from the steamer's deck, brings his boat and passengers safely alongside, often just behind the paddle boxes. The passengers being helped on board, the rowing boat sheers off from the bigger vessel and is almost directly out of danger to be taken by the wake-stream as at a couple of feet only from the steamer's side the ferryman takes up the oars and pulls back towards the shore, whereas the steamer puts on "full speed" again as soon as the towing rope is let go.

Do not these simple facts teach us some valuable lessons as to the movement of the water in the vicinity of a moving ship?—Lessons which may be summarized as follows: The bow of each vessel drives a quantity of water before it, in a direction normal to the curvature of the water-lines of the fore body. The water thus set in motion is at once retarded by setting in motion other particles of water by mere contact with those originally touching the ship. This retardation extends over a certain distance from the ship, dependent on the original velocity of the disturbed particles *i. e.*, on the speed of the ship. The water being retarded, the ship at its uniform speed overtakes the retarded water and so apparently "cleaves" the water whereas in reality it drives the water in front of itself.



The quantity of water thus displaced and set in motion in each second must be equal to the immersed area of the midship section multiplied by the length of advance in one second thus equalling the volume which would have to be dug out from a solid to displace the ship over the same distance.

At the same time as the midship section is moved over a certain distance ahead there remains an equal volume of water to fill up the space which would be left open at the stern when moving the ship in a solid matter. This volume of water cannot be composed of the same particles as those that were driven in front of the bow. Other particles which were at rest near the stern rush in from the sides and in a direction ascertaining the shortest possible way towards the destination *i. e.*, in lines normal to the curvature of the water-lines of the after-body.

The ship leaves this moving water behind her and the original wave set up by the bow as well as the surrounding water spreads over the surface from which the water was taken to fill up the original hollow created at the same time as the bow-wave.

Instead of the retarding influence met with by the bow-wave before it reaches the canal bank there is an increase of velocity from the bank towards mid-channel to be expected near the stern. The more gentle the slope of the bank the greater the distance over which the required quantity of water has to flow in a given time as the depth fails to produce the necessary quantity within a short distance.

Where sufficient depth is available the whole process of retarding the motion at the bow and of filling up the hollow at the stern is effected in a period of time so short and extending over so small a distance from the ship that the foam created at the bow is at rest and not subject to any transverse movement when passed by the stern, hence the two lines of foam show no tendency to approach each other.

In a short vessel with bluff after-body the "filling-in" cannot begin until the full stern has nearly completely passed. At the generally slow speeds of such vessels the distance to which the foam is thrown away from the bow is only insignificant hence in these cases parts of that foam-covered surface flow towards each other from each side of the ship.

In this way it may be explained that canal banks may be considerably damaged by the wake of a steamer passing nearby at a comparatively great speed. The "rushing in" of the water "gnaws" at the banks; the bow-wave can only cause a deposit of floating impurities to "touch" them.

It now remains to be considered how the steering is affected by the motion of the water, and how when touching the bank it is always the bow that comes into contact with it and not the stern.

As a matter of fact no master of a canal boat will steer his ship into the bank unless this should be necessary to avoid a greater danger, so generally it will be only necessary to consider what is likely to happen when a ship, steering a course *parallel* to the bank is getting too near the one side of the channel.

The bow-wave will be traveling on as usual; the retarding effect of other particles of water can only be assisted by the influence of the shallower depth, but this extra retardation does not interfere with the direction of the ship. But inasmuch as the cross-sections of the after-body require a continually increasing velocity of the water flowing towards it to fill up spaces which continually increase in volume up to a certain maximum there will be a stronger influence of current nearer to the stern than immediately abaft the midship section.

This current, coming in from sideways, remains normally fed from the side of mid-channel but the nearer the vessel may be to one of the banks the greater the want of water on that side will be, and thus the required volume of water begins to flow in partly in a direction from aft, as indicated in the diagram, Fig. 2, annexed. The perfect balance between the two opposed currents, one acting on each side of the after-body, is then no longer maintained, whereas this balance remains maintained at the bow, consequently the stern is turned more towards mid-channel, causing the bow to run into the bank. The rudder affords no help in this event; on the contrary, its tendency is to do the reverse. Say, for instance, that the vessel is dangerously near to the starboard bank, then the rudder will have to get starboard helm to make the vessel sheer off, but as this means that the rudder itself is turned to port, it offers a greater surface to the current rushing in on the starboard quarter, and thus assists in driving the stern in the wrong direction.

In the case of one vessel overtaking another the same causes will have the same effect unless the distance between the two be sufficiently great to keep each clear from the other's influence, or unless the speed of the overtaken vessel be very much reduced.

Let us suppose, again, that the overtaken ship be on the starboard bow of the overtaking vessel. As soon as the starboard bow-wave of the overtaking ship comes within the influence of the flow of water closing in on the port side of the foremost vessel the resistance against the two sides of the bow becomes unequal, as the port bow of the aftermost vessel continues to meet the original resistance, whereas at the starboard bow this resistance is diminished by the motion of the water flowing towards the stern of the

*From *Engineering*.

foremost ship, thus creating a suctional influence on the bow-wave and drawing the bow out of its safe course (see Fig. 3). Dependent upon the lengths of the two vessels, but supposing the overtaking one to be the shorter, there will necessarily be a moment when the filling up of both stern hollows can only be fed from astern and the combined influence of the lesser pressure on the starboard bow and the extra pressure at the starboard stern will drive the overtaking ship helplessly into collision with the foremost. If the foremost ship be the shorter of the two the same danger will only be encountered somewhat later, the stern hollow of the longer ship then drawing the bow of the shorter towards her by diminishing the bow resistance on one side only.

Bearing in mind the volumes of water which play their part in this condition, accidents are easily explained. In the case of the Olympic-Hawke disaster, for instance, there will have been a quantity of between 1,500 to 1,600 tons of water flowing in one second towards the Olympic, a quantity fully sufficient to diminish very seriously the pressure on the corresponding side of the Hawke's bow, whereas on the opposite bow there remained the pressure due to the setting in motion of perhaps some 1,000 to 1,200 tons per second. No wonder that the consequences of this state of things were disastrous to both vessels.

And may not the cause of the lamentable Titanic disaster be explained as well by the same reasoning? Supposing this vessel to have been steaming in a direction parallel to the iceberg which tore up its side to such an enormous extent, the phenomenon described as of common occurrence in inland navigation must then have repeated itself, "a want of water between the ship and the floating mass of ice," and the splendid powerful ship, the largest passenger ship then afloat, was driven toward its inevitable doom.

When two vessels are meeting each other in a parallel direction the circumstances are quite different again. As indicated in Fig. 4 the two bow-waves meeting in opposite directions have a tendency at first to drive the two vessels from each other, and there remains only the danger of touching each other sideways in a far less serious way than in the case just considered.

This latter risk is explained when it is considered that in passing each other there will be acting on each ship an unbalanced lateral pressure working from outside at the moment when the bow-wave of the one ship will encounter the stern hollow of the other at the adjoining of each. The different conditions here considered will be clearly illustrated by referring to the diagrams.

The Preparation of Helium

The preparation of this highly interesting chemical element in absolutely pure form, and recent investigations upon its occurrence in nature, have brought to light some interesting facts regarding it. To obtain pure helium the chemist makes use either of the non-liquefiable residuum obtained in the preparation of liquid air, or else of the gases which are disengaged when certain radio-active minerals, such as thorianite, are heated to 1,000° C. These gases are successively deprived of oxygen by calcium, and of nitrogen by oxide of copper at a red heat; after being washed with sulphuric acid they are roughly purefied by contact with charcoal, which has been chilled to the temperature of liquid air. The remaining gases are again made to pass through a column of incandescent copper oxide, and finally, after having been repeatedly subjected to the action of the chilled charcoal, pure helium alone remains.

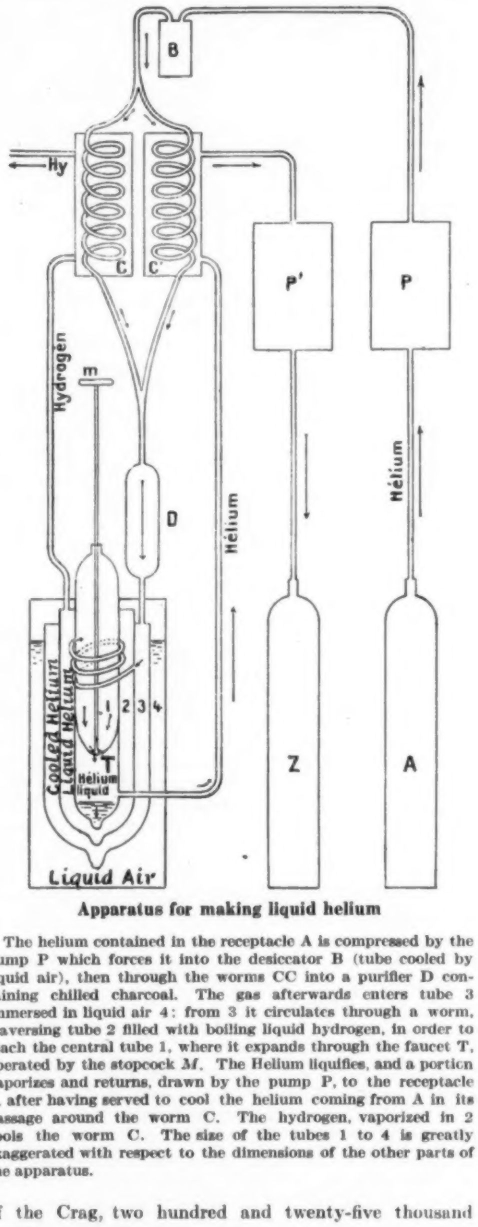
The charcoal required in this process of purification must have been recently prepared, and must have had its pores entirely freed of all gaseous content by heating to 400° C. The best variety is that prepared from the shells of cocoanuts. This is extremely dense but at the same time highly absorbent (one gram fixes from 300 to 400 cubic meters of air), and this absorbent power is greatly increased by chilling. Thus at 0° C. one part of charcoal will retain two volumes of helium or four volumes of hydrogen; while at the temperature of liquid air (minus 185° C.) it will retain fifteen volumes of helium and one hundred thirty-five volumes of hydrogen. This absorption process, which was invented by Dewar, makes possible the absolute purification of pure helium, since this gas is less absorbable than all other known gases which accompany it.

The pure helium thus obtained is a colorless gas having a density of 0.17856 (Heuse, 1913); assuming the molecular weight of oxygen to be thirty-two, that of monoatomic helium would be 4.002 according to the experimental measurements thus made.

In 1899 Dewar undertook to liquefy helium, after having succeeded in solidifying hydrogen; the result obtained convinced him of the possibility of obtaining liquid helium at about—269° C. This investigator found that helium underwent a change of state when cooled by solid hydrogen under a pressure of eight atmospheres; but it was not until 1908, that the Dutch scientist Kamerlingh Onnes, (winner of the Nobel prize in 1913), succeeded in actually liquefying helium in appreciable quantities by means of the powerful apparatus in his cryogenic laboratory at Leyden. This physicist succeeded in liquefying helium by subjecting it to a pressure of one hundred atmospheres at a temperature of liquid hydrogen boiling under a very reduced pressure of six centimeters, representing a temperature equal to—258° C. Helium forms a liquid having a density of 0.154 boiled at 4.3° C. absolute, or—268.7° C.; all efforts to solidify it have thus far failed. The obtaining of liquid helium is highly remarkable not merely because of the numerous difficulties which had to be overcome but because the temperature attained is the lowest which mankind has ever been able to reach.

Helium exists in the atmosphere, one million liters of air containing five liters of helium according to the engineer Claude. It occurs in nature wherever radio-active substances are found; Ramsay and Soddy demonstrated this formation, starting with the disaggregating of the atoms of radium, polonium, ionium, uranium, etc. According to calculations made by Dewar one gram of radium daily disengages, by reason of its disintegration, 0.43 cubic millimeters of helium.

Its presence has been frequently noted in various rocks. This fact has enabled geologists to estimate the approximate age of certain terrestrial formations by means of a comparison of the content of helium with that of the radio-active substances co-existing at the same spot. Some of the periods of time thus estimated are enormous. Thus archaic rocks are computed to have an age of seven hundred million years, thorianite of two hundred and eighty million years, the hematite covering the carboniferous of one hundred and forty-one million, the phosphatic nodules of green sand three million and eighty thousand, and the phosphatic nodules



Apparatus for making liquid helium

The helium contained in the receptacle A is compressed by the pump P which forces it into the desiccator B (tube cooled by liquid air), then through the worms CC into a purifier D containing chilled charcoal. The gas afterwards enters tube 3 immersed in liquid air 4: from 3 it circulates through a worm, traversing tube 2 filled with boiling liquid hydrogen, in order to reach the central tube 1, where it expands through the faucet T, operated by the stopcock *M*. The Helium liquifies, and a portion vaporizes and returns, drawn by the pump P, to the receptacle Z, after having served to cool the helium coming from A in its passage around the worm C. The hydrogen, vaporized in 2 cools the worm C. The size of the tubes 1 to 4 is greatly exaggerated with respect to the dimensions of the other parts of the apparatus.

of the Crag, two hundred and twenty-five thousand years.

Moureu with various collaborators, including Lepape and Biquard, has studied the helium found in gases issuing from the earth, either free, coming through mine gases or in the gas given forth by mineral waters. Through a special spectro-photo-metric method the interesting conclusion was reached that helium is found everywhere; its spectrum is exceedingly clear, defining it with a precision of one three hundred and sixty thousandth part of volume.

The daily emission of helium in coal mines may run as high as ten cubic meters; at Mons the gravel contains 0.3 per cent of helium, a proportion which is considered large compared to that of the content of the atmosphere.

Both in mine gases and in mineral waters, helium is accompanied by other rare gases (neon, argon, crypton xenon); in the latter the proportions vary according to the springs from which they are derived. The Vauquelin Spring at Plombières yields 0.206 vols. per one hundred volumes of the gases disengaged; the Lymbe Spring of Bourbon-Lancy yields 1.83 vols.; the La Maizières (Cote-d'Or) 5.77 vols.; the Luthium Spring at Santenay (Cote d'Or) is the richest thus far known, the quantity of helium attained 10.16 vols. The Lithium Spring disengages annually 5.82 cubic meters of helium; the Carnot Spring at Santénay 17.845 cubic meters and the César de Néris (Allier) 33.990 cubic meters.

Since it is definitely established that helium is the result of the disintegration of radio-active substances these figures enable us to estimate the amounts of such minerals existing in localities where the gas is given off. The amount produced by the Carnot Spring for example would require the disaggregation of the radium content in five hundred million tons of uranium ores; moreover since the radio-activity of a spring and its helium content bear no relation to each other, we are forced to the conclusion that the helium observed, or at any rate the chief part of it, cannot be of recent origin; hence it must exist already formed in the bowels of the earth. This *fossil* helium must proceed from previous disintegration, the liberated gas remaining confined within the earth; according to this hypothesis the quantity of radio-active substances required for the gas issuing from the Carnot Spring would be reduced to one hundred and fifty tons of uranium ores, which appears far more probable.

It is notable that helium, whether found in gravel or water, is invariably accompained by other rare elements of the same series. This fact is evident from the experiments of Ramsay and his pupils, Collie and Paterson (1913). These investigators transformed hydrogen into helium by means of new transmutations. The hydrogen is polymerized by means of an electric discharge in a vacuum tube containing traces of the gas.

By a very slight modification the addition of oxygen is found to yield neon, that of sulphur to yield argon, that of selenium to yield crypton, thus proving that these gases have a common origin. The molecular weight of these various gases is as follows: helium 4, neon 20, argon 30.9, crypton 82, xenon 127, niton (emanation) 220. The boiling point of helium is—268.7° C., that of neon—220° C., argon—186° C., crypton—151.7° C., xenon—109° C., niton—65° C. Since helium has not been solidified the melting point is not known but that of neon is—250° C., argon—188° C., crypton—169° C., xenon—140° C., niton—71° C.

Moureu's researches show that the proportions of these gases bear a constant relation to each other wherever they are collected. It may be believed (Astro Physical Theory by Meureu and Lepape p. 911) that these gases which are chemically inert existed or were formed in the initial nebula and have been able to resist because of their inertia considerable variations of pressure and of temperature. In the original nebulous mass they were distributed uniformly; but by reason of their inertia they have remained unconcerned witnesses of the multiple convulsions of the globe constantly retaining the same proportionate relation which marked them in the beginning.

According to the investigations of chemists helium seems to be the most disaggregated form among all atoms. When atoms undergo disaggregation they give birth to less heavy and less complex atoms liberating helium. —*Larousse Mensuel.*

The Blue of the Sky*

And Other Phenomena of Molecular Diffusion

By Prof. Charles Fabry, of the University of Marseilles

There is no need of describing the phenomenon of which I am going to speak to you. Each of us has often been impressed by the lightness and beauty of the splendid azure vault above our horizon. The blue sky is very often invisible, to be sure, but we know that this is merely because it is hidden by clouds or fog; in order to find it again we need only to rise above the lower atmosphere. It is therefore a constant phenomenon, possessing the same character in all lands and in all climates, though at times hidden or covered by accessory phenomena. Whence comes this light with which every object is bathed on a clear day, and which tempers the too harsh contrasts of solar light, and why should this light be blue?

The blue sky is obviously a gift of the sun, since it disappears when the sun disappears. This simple observation leads to the belief that the light of the sky is the light of the sun, diffused by something which exists above us. Moreover, it is composed of the same elements as solar light; we find in it green, yellow and red; it is blue because the rays of short wave length are particularly numerous in it. Qualitatively the solar spectrum and the spectrum of the blue sky are identical. All the black lines of the first are found in the second, and this confirms us in the idea that the light of the sky is merely diffused solar light. Quantitatively the two spectra shows a different distribution of intensities, with a great predominance of waves having short wave length in the spectrum of the sky. These simple observations at once suggest a theory to explain why the sky is blue. Somewhere above us there must be something which, upon receiving the solar light, diffuses it in every direction. Whatever this thing is it does not create the light, but confines itself to reflecting it, and its power of diffusion is greater for short waves than for long waves[1]. This thing is in our atmosphere since the phenomenon vanishes when the latter ceases to be illuminated. In short it is not an exceptional and accidental element; it is a constant element which exists in all parts of our planet. What is this mysterious blue apparition? We have had to make a good many mistakes before we arrived at the true explanation, which is, however, very simple: That which diffuses the light of the sun and gives us the blue sky is the air itself; it is the molecules of air which act like minute obstacles placed in the path of luminous waves, and reflect these in all directions. These molecules are so small that the waves which are comparatively long pass around them with scarcely any interruption, while the shorter waves are much more diffused. Any larger particle of matter merely has the effect of disturbing the phenomenon or hiding it completely. It is the air and the sun alone which give us the blue sky.

Let us examine the matter somewhat more in detail, and see whether this theory which is so beautifully simple can be accepted in the last analysis. As we know, light is merely a traveling vibratory movement; matter is in no wise necessary for its propagation; it is in a vacuum that light is best propagated entirely without loss of energy. Moreover, there is not merely one species of light; on the contrary there are an infinity of species distinguished from each other by their rapidity of vibration, or what comes to the same thing, by their wave lengths or the distance between two successive crests of the propagated disturbances. Confining ourselves to these perceived by the human eye, the shortest waves yield violet radiations whose wave length is $0\mu 4$; then we pass progressively through the blues, greens, etc., to the extreme red, whose wave length is about $0\mu 8$. All these waves are excessively short since the longest are less than a thousandth of a millimeter in extent. In the propagation of these waves every kind of matter forms an obstacle. Whenever a luminous wave encounters a material body it suffers to some extent. It may be absorbed and transformed into heat, that common form of energy; it may be regularly reflected, regularly diffused, partially refracted. The history of these modifications constitutes a large part of the science of optics; the form of the surface encountered, and the essential properties of the body, all help to give each case a special character.

In this complex ensemble one special and very remarkable case was studied about forty years ago by the great English physicist, Lord Rayleigh; this is the case when the material obstacle encountered by light is extremely small, smaller even than the smallest wave length; that is, less than a minute fraction of a micron. Such an obstacle naturally diffuses an extremely small quantity of light, but it does not act in the same manner upon all these radiations; those whose wave length is comparatively large are but slightly affected by the presence of a very small obstacle, which does not disturb them any more than a floating cork stops a large wave in water; the very short waves are more strongly diffused, like slight waves surmounted by a small floating body. Correspondingly, the violet and blue radiations are more diffused than the red ones; our little obstacle illuminated by a pencil of rays of white light would appear to an eye keen enough to perceive it as a blue point.

In place of a single small obstacle invisible to the human eye, let us suppose millions of them receiving the rays of the sun; each of them will yield a small quantity of blue light, and the eye, which is incapable of separating them from each other, will perceive a blue cloud.

This beautiful theory, whose mere framework I have here given, has received beforehand striking confirmation from a curious experiment made by Tyndall. This skilled physicist caused a pencil of light rays to pass through air charged with excessively minute particles of matter; to obtain these he made use of gaseous mixtures, which the light itself decomposed into extremely fine particles. At the first instant that the light struck the gas, the tube appeared to be empty. At the end of a very short period of time, however, the precipitate was formed, and the vessel had the appearance of being filled with a blue cloud. Soon afterwards the minute droplets grew larger; without becoming enormous they become larger than the lengths of the luminous wave; and therefore diffused all the radiations indistinctly, so that the delicate blue cloud was transformed into a coarse white cloud.

This phenomena of diffusion by fine particles is very often to be observed in fact. The smoke from tobacco or incense often appears to form a blue cloud when illuminated by solar rays. But if the smoke happens to be formed by coarser particles, it appears as a white fog. Tyndall did not fail to perceive the analogy between the blue cloud thus formed and the light of the sky; he said to his auditors: "In this glass I have produced a scrap of the firmament." The resemblance goes still further than with regard to the color. The light diffused by these fine particles is polarized, that is the luminous vibration instead of being directed in an incoherent manner in every direction is made in a definite plane. This peculiarity is perfectly explained by Lord Rayleigh's theory; but the light from the sky is also polarized, and is polarized in exactly the same manner as the light diffused by the fine particles in Tyndall's tube.

Here then we have preliminary outline of the corpuscular theory of the blue of the sky. According to this the light of the firmament is solar light diffused by fine particles floating in the air; the blue color of diffused light is explained by the extreme smallness of these particles, whatever their nature may be and this also explains their state of polarization. It must be admitted that according to this theory one point remains obscure—the nature of these diffusing particles. They have very much the appearance of having been invented to meet the requirements of the theory. It is not improbable to be sure that under exceptional conditions very fine floating particles do exist in the upper atmosphere; but the blue of the sky is not an exceptional phenomenon. It exists constantly and is practically always the same. If this blue light therefore comes to us from such fine particles, they must constitute a permanent element of our atmosphere. This problem also was solved by Lord Rayleigh and the explanation is more simple and more beautiful than could have been imagined. These diffusing particles are the molecules of the air itself. They obviously constitute a constant element of our atmosphere, since they form the very substance of the air itself. As we know the molecular theory of the atmosphere has become both more certain and more definite of recent years. The idea that all matter is composed of an aggregate of extremely small distinct particles is almost as old as human thought itself, but remained for centuries in a state of vague speculation. Little by little modern science has made this idea definite; alternately defended and combated, both by physicists and by chemists, it has emerged from each dispute stronger and more precise; today it has ceased to be a mere philosophic idea, it has acquired the precision of a theory. We are now able to count these minute entities and fix their dimensions, to state the number of atoms each of them contains, and the arrangement of these atoms. We will here confine ourselves to a statement of what we know concerning the molecules of air.

The air which is a mixture of two gases contains two kinds of molecules, those of oxygen and those of nitrogen; these are very different as to their essential properties, but comparatively similar with regard to their dimensions and their external aspect so to speak. The number of these molecules is immense and their smallness almost inconceivable. A cubic millimeter of air which weighs approximately one thousandth of a milligram, contains about twenty million billions of molecules. The diameter of each of these is so small that if placed end to end it would require three millions of them to cover one millimeter in extent. These molecules, therefore are very far from touching each other in the air. There are spaces between them not like those in a bag of nuts but rather like those in a swarm of gnats, in which each flying insect represents a molecule. The empty space in the air is about a thousand times as great as the space occupied by matter. Hence, the molecules are in a state of continual agitation, striking and displacing each other with a rapidity whose degree corresponds to the height of the temperature.

A single molecule is evidently too small to be seen. Lord Rayleigh's brilliant idea was, that in spite of its minute size, each molecule must diffuse a trace of light; to the eye which was sufficiently keen, a single molecule of air illuminated by the sun would appear like a small blue star, for such a molecule because of its very smallness of size, realizes marvelously the small obstacle concerned in a corpuscular theory. While no human eye is sufficiently keen to observe this phenomenon as regards a single molecule, since the billions of molecules which compose the air all act in the same manner, the eye must receive from the mass of air illuminated by the sun the image of a blue cloud; this blue cloud is in reality a "Milky Way"; a nebulous mass wherein each star is a single molecule.

This theory admirably explains the blue of the sky from the qualitative point of view. But this is not sufficient; to be exact it must take account of the intensity of the light observed with regard to the number of molecules, and of those properties of theirs which are already known and are not invented for the requirements of the theory; this numerical test has completely confirmed the theory. Lord Rayleigh's formula, which gives the intensity of the light of the sky, contains, as might be expected, the number of molecules contained in each unit of volume. Moreover, this luminous intensity is known to us through observation; with the theoretic formula, we are able to calculate the number of molecules contained in each cubic millimeter of air. This calculation gives the exact number cited above, which was obtained by entirely different methods. We may, therefore, consider the theory to be complete, since it agrees numerically with the observed facts.

But experimental confirmation was still lacking. It remained to be demonstrated by a laboratory experiment that pure air reflected the light in every direction when traversed by a luminous pencil; there remained the problem of making a little artificial firmament in a tube, not as Tyndall did, with specially diffused particles, but with pure air. This experiment, which is very

*A lecture delivered before the Astronomical Society of France, December 2, 1917. From *Revue Generale des Science*.

[1]Another explanation of the blue *color* of the sky may occur to the mind: it may be imagined that there is present in the atmosphere a blue gas, acting upon light like blue glass, *i. e.*, by absorption. But before explaining the *color of the sky* it is necessary to explain its *light*, for blue glass colors light but does not create it. The theory of a blue gas, therefore, does not enable us to dispense with the supposition of the existence of something which diffuses the light. Even when thus completed the hypothesis of a blue gas fails to stand. Such a gas would necessarily act upon all light which traversed it, upon the direct light of the sun as well as upon that of the sky; it would impart the blue color not only to the light of the sky but also to that of the sun, and of the moon, and this blue color would increase in direct proportion to the depth of the air traversed; hence the setting sun would become bluer and bluer instead of redder and redder. Therefore the consequences of the hypothesis contradict observed facts.

Yet this untenable hypothesis is often offered, the blue gas being said to be Ozone. It is quite true that Ozone exists in our atmosphere, and that this gas plays an important part in the physics of the globe. Irrefutable proof of its existence has been given recently by Fowler and Strull; but the existing quantity is much too small to enable the blue color to be manifested. Moreover this color is due to characteristic bands of absorption which entirely fail to appear in the light of the sky. If the quantity of Ozone in our atmosphere were a hundred times as great as it is its blue color might become perceptible, but it would produce effects entirely different from those which we are trying to explain.

difficult because of the feebleness of the light diffused by a small volume of air, was accomplished shortly before the beginning of the present war by a young physicist, M. Cabbannes, working in a laboratory of the "Faculté des Sciences" of the University of Marseilles. M. Cabbannes succeeded in demonstrating by direct experiment that pure air diffused light according to the laws long ago laid down by Lord Rayleigh in his explanation of the blue sky.

There remains, therefore, no longer a shadow of a doubt that the diffusion of light by molecules of air is not a mere hypothesis, but the expression of a fact. When the sun is near its zenith on a fine day in summer, it floods the air above us with light; the air does not allow this flood of light to traverse it without diffusing some portion of it, and it is the short waves of blue light which are especially affected; it is this diffused light which forms the blue of the sky. We do not live *under* the firmament, we live *within* the firmament; all the layers of air contribute to this phenomenon, not only the sky but the remote vistas of the scene are bathed in this blue light. Each cubic centimeter of air, whether near or afar, becomes a source of blue light whose intensity is capable of being precisely calculated as follows: Take a volume of fifteen cubic meters (a sphere of about three meters in diameter) of this air saturated with solar light, transport it into a dark room, and suppose that by some miracle it is able to retain the luminosity which it possesses in full sunshine; it would then yield a luminous intensity of one candle-power, sufficient to enable one to avoid obstacles. If the aforesaid room were full of such air, we should be able to extinguish the lamps and still be able to read by a soft blue light, which would remain.

Naturally when the pencil of sun rays passes through the air which partly diffused it, it gradually becomes enfeebled, becoming poorer in blue rays than in red rays. When the sun is at its zenith, its rays are not much enfeebled, since they traverse the atmosphere through a shorter distance. But the rays are increasingly enfeebled as the sun descends towards the horizon, since they have an increasing thickness of air to travel through. At the horizon they are very greatly affected, so that it is only the red which reach us, those of small wave length having been cut off. The red of the setting sun is a complement of the blue sky. Such are the phenomena produced by pure air; but our atmosphere is very often mingled with thousands of foreign substances. The minute drops of water which form clouds, fogs or rain, or the crystals of ice which compose beautiful white cirrus clouds, the dust from volcanoes or from the ground, or the fine particles of soot coming from our chimneys—these foreign elements which are infinitely larger than the molecules of air disturb the phenomenon due to the latter, sometimes rendering it totally invisible, and sometimes covering the blue light of the sky with a white veil.

But let us return to pure molecular diffusion. So simple a phenomenon cannot fail to be presented under many aspects, both upon the earth and outside of our own planet. Let us follow these various manifestations.

Upon the earth every pencil of light rays is necessarily subjected to molecular diffusion because of the presence of the air. The pencil of light rays from a searchlight directed towards the sky is visible, although nothing but air lies in its path. While it is true that both dust and minute drops of water play some part in this diffusion of light, especially in the vicinity of the ground, it is molecular diffusion which is chiefly concerned in fine weather in the upper reaches of the atmosphere, and it can be proved by calculation that such diffusion is sufficiently intense to make such a pencil of light rays visible for a very long distance.

But the diffusion of light is not an exclusive privilege of the air alone; any other transparent fluid must act in the same way. This must be true in fact of water and since the molecules of water are much closer together, and much more numerous than in an equal volume of air this diffusion must be correspondingly more active. A mass of pure water illuminated by the sun must be luminous not merely by reason of its surface reflection of the light from the sky but also throughout its entire mass. There can be no doubt that this diffusion plays an important role in the varied and fascinating effects of light exhibited by the sea as well as in what may be called "Submarine Optics." When the submarine boat is submerged in pure water, if we look through the glass walls of the conning tower everything we see appears to be bathed in a greenish blue light which veils every object and renders them invisible at a short distance. While this phenomenon is undoubtedly partly due to the absorption of light by the water the principal cause is certainly the diffusion of the light by the molecules of the water. Under such conditions we find ourselves within a firmament which is far more dense than the firmament of the air, so dense that the horizon is only a few meters distant.

Whenever a new terrestrial phenomenon is discovered or explained, the question arises whether something analogous does not exist elsewhere in the universe. Correspondingly, may we not be able to discover in the theory just stated the explanation for some celestial phenomenon, which has hitherto been regarded as mysterious? Curiously enough this question has not heretofore been raised with regard to the diffusion of light by gases. Yet a phenomenon so simple cannot fail to be produced elsewhere than upon our own planet; the only elements necessary for its production are a gaseous mass, however rarefied, and the sun to illuminate that mass. Let us pass rapidly in review the various celestial phenomena wherein such diffusion may play a part.

Every planet which possesses an atmosphere must have a blue sky, which we upon the earth observe from the exterior. In the moon, which is entirely or nearly deprived of all atmosphere, the inhabitants, if it had any, would live under a black sky, wherein the light of the sun would be projected without modification. Mars, whose atmosphere is less dense than our own, must have much less luminous sky than ours; when it is clear this firmament does not hide from us the details of the surface of Mars. It is probable that Jupiter, on the contrary, has an atmosphere which is much denser than that of the earth. In Jupiter, therefore, the blue of the sky must assume a very special aspect: Even in the absence of any water vapor the atmosphere must hide the sun from an observer placed upon the surface of this planet, since an atmosphere twenty times as dense as our own would allow only a feeble red light to filter through it; what we are able to see of this planet is only the outside of its firmament.[2] The red spot which we observe upon Jupiter possibly derives its color from the fact that it is illuminated by light which is filtered through a great thickness of gas.

In the planets the atmosphere is merely an adjunct; other celestial phenomena appear to be due to bodies which are purely gaseous. This is probably true in the case of the corona of the sun; but the question at once arises as to what substance is sufficiently refractory to withstand the enormous solar radiation at such close range. The spectrum analysis shows that the light of the solar corona has a twofold origin: a luminosity proper to itself characterized by a spectrum formed by a small number of brilliant lines, and a continuous spectrum attributable to diffused light. To my mind it appears exceedingly probable that the diffusing substance is the very gas of which the corona is composed. If this be true the polarization of this light has a natural explanation like that of the light of the sky, while the light which is diffused by solid particles shows the merest trace of polarization. It even seems possible that molecular diffusion may be able to explain a fact which has hitherto remained a mystery: namely, that the black lines of the solar spectrum do not appear in this light. This fact would appear inexplicable if the diffusion is due to solid particles, whose presence so near the sun, moreover, would seem to be highly improbable.

The molecules of a gas, on the contrary, being in a state of motion which becomes increasingly rapid with the rise of temperatures, the light which they diffuse is modified by the Doppler-Fizeau law. Each simple radiation being replaced by a minute morsel of the continuous spectrum, the fine black lines of the spectrum would be suppressed, provided the diffusing substance be a very light gas and possess a very high temperature.

As for the quantity of gas required to produce the solar corona, it is extraordinarily small: a density much less than the billionth part of that of our own air would be sufficient to explain the light observed. It is not at all surprising that comets have been able to traverse such a medium without experiencing the slightest resistance.

The zodiacal light may be regarded as being susceptible of the same explanation. Unhappily the data necessary to support the theory are practically lacking. Visual observations are numerous, but purely descriptive. The employment of photography would enable us to obtain without much difficulty definite data concerning the polarization of this light and the composition of its spectrum (at least by a "color index" measurement). The necessary apparatus would be neither costly nor complicated, but the majority of our observatories are too near cities to be advantageously made use of.

At night, when the sky is cloudless and when one is in an open place, there is never entire obscurity—one is able to finds one's way without any trouble, and one can even read large print such as the title of a newspaper. Whence do we receive this light? The question has as yet not been sufficiently studied for a definite answer to be given.

Where superficial observation suffices to show that its intensity is not constant, one often remarks nights which are peculiarly bright. I had the opportunity of observing one of these under conditions which utterly precluded the influence of artificial light from being assigned as a cause. It was upon the occasion of my return from a recent journey to the United States at a moment when we were at a nearly equal distance from each of the two continents; the boat itself, for reasons, was immersed in absolute darkness; the sky was perfectly clear, and at the time when I made my observations any illumination proceeding from the moon or from a lingering remnant of twilight was quite out of the question. Yet the sky was so luminous that its luster rendered it difficult to perceive the Milky Way, and the general illumination was quite exceptional. These bright nights are usually attributed to a faint diffused aurora borealis which illuminates the whole sky. But aside from these exceptional cases there remains a remarkable luminosity which appears to be constant and which probably has some extra-terrestrial cause. Very few measurements have been made. I myself indicated, some years ago, a very simple photographic method for measuring the *intrinsic brilliance* of the nocturnal sky; the measurements made by me, though all too few, show that this luminosity is constant, aside from exceptional nights. Its intensity is apparently too great for it to be attributed to single stars. We are therefore led to believe in the presence, in the space which surrounds us, of something which is luminous, probably by reason of the diffusion of solar light. To explain this phenomenon we need only suppose that there exists in space an extremely rarefied gas, of a density lower than 10^{-14} with respect to that of our own air; in such case the luminosity of the night sky is likewise a residuum of blue sky due to an extra-terrestrial gas.

So rarefied a gas would offer no appreciable resistance to the movement of the stars; its molecules would be so remote from each other that each might travel many thousand kilometers before striking another.

This same hypothesis of a cosmic gas was proposed recently by Mr. Vessot King to explain the absorption of light in its passage through space. It is a well known fact that certain observations of sidereal astronomy have led us to believe in a slight absorption of light while traversing space, so very slight, indeed, that centuries of propagation would be required for the loss of energy to become perceptible. We might attribut this loss of energy to diffusion by a highly rarefied gas, and the density of this gas could be calculated by making use of data (which are, it must be acknowledged, very uncertain) as to the percentage of enfeeblement which the light undergoes in its voyage. It is curious to note that this calculation gives a result which is precisely of the same order of magnitude as that to which we have had recourse to explain the light of the sky. Is this pure coincidence, or the confirmation of a theory? It would be rash to affirm it. A number of measurements of the luminosity of the sky compared to the number of stars visible, and a certain amount of research regarding the polarization of this light and the composition of its spectrum, would give to this theory of a cosmic gas a surer foundation than any amount of speculation.

The tails of comets offer us another example of diffused light. As in the case of the solar corona their spectrum reveals a double origin: their own light, producing a spectrum of bright lines, and diffused solar light yielding a continuous spectrum. But what is it which diffuses the latter? Solid particles of dust or the isolated molecules of a highly rarefied gas? Here again our data are insufficient to be decisive. If we make use of the hypothesis of molecular diffusion it is proper to imagine what density of gas is required to produce the observed phenomenon. Let us offer a suggestion thereupon.

Let us in imagination cut out a slice of our atmosphere which is very wide but only one millimeter thick. Suppose this to be transported just as it is to some position far beyond the confines of our atmosphere in such manner that it shall receive the rays of the sun in the middle of the night; suppose we view it from such a position that in the direction of the visual ray it shall still have a thickness of only one millimeter. The brilliance of this meteor could be calculated and we should find that it made in the noctural sky a spot as bright as the Milky Way. Suppose now that this millimeter of air dilates, in thickness only, until it is several times the diameter of the earth; our gas would then be extremely rarefied, but its degree of brilliance would remain the same. If a comet is a gas, then it must be similar to the above. It will be recalled that

[2]The light we get from Jupiter is bluer than that of the sun. According to Russel the "color index' of Jupiter with respect to the sun is—0.29. (*Astrophysical Journal*, March, 1916.)

a few years ago the Earth passed through the tail of Halley's comet; some fear was entertained with regard to the poisoning that might result from the introduction into our atmosphere of noxious gases contained in the wandering star. The event proved the danger to be imaginary as it was easy to foretell; for whatever the nature of the gas it could be present only in quantities too small to perceive. A density of one milligram per thousand cubic meters is certainly not attained, for such a density would produce a luminous phenomenon such as no comet has ever exhibited.

I will take note of a final case, particularly curious, wherein is concerned light diffused by the matter expanded through space, possibly by a highly rarefied gas. I refer to the nebulosity surrounding a new star, the progress of whose development we have been able to observe.

Every one has heard of these strange sudden apparitions of stars, sometimes very brilliant. A beautiful example of this phenomenon occurred a few years ago in the constellation of Perseus.[3] Close observation of the new star revealed the following curious appearance; a short time after the apparition of the Nova, when it had already entered upon its decline, a faint nebulosity was seen to develop around it; this grew gradually larger in diameter like a ring spreading in water. It seems certain that this appearance was due merely to the successive illumination of the particles of some tenuous substance existing in that region of space wherein the new star appeared. The new star suddenly projected a flood of light, propagated at a speed of 300,000 kilometers per second, an enormous speed when measured by our petty scale, but infinitesimal when compared with the immensities of celestial space. One after the other the diffusing particles were illuminated, presenting the aspect of a ring constantly increasing in diameter. We have thus been enabled actually to *see* light propagating itself . . . . Before the explosion the diffusing matter, probably a highly rarefied gas, was invisible for lack of light to illuminate it; it could have revealed itself only under the form of one of those *black nebulae*, discovered by Bernard, visible as dark masses which cause the stars behind them to disappear by reason of their absorption of light.

But I perceive that in treating of a terrestrial phenomena I have little by little led you to the confines of the known universe. We may judge by this how arbitrary are our divisions between the sciences. Celestial phenomena, those which constitute terrestrial physics, and those which the physicist studies in his laboratory, are essentially the same. Where does physics end and astronomy begin? This question may serve me for an excuse for allowing myself, a mere physicist, to be led by my subject far beyond the narrow bounds of my laboratory.

[3]This observation is of peculiar interest at present since such a brilliant star has recently appeared in the sky and is now being watched by astronomers with great interest.—*Editor Sci. Am. Sup.*

Proposed Cross-Channel Train Ferry

Among the proposals for facilitating cross-Channel transport between England and France, the construction of a bridge had at one time many advocates, while the partial filling in of the Channel, so as to leave a passage three miles wide, has also been seriously suggested. The boring of a tunnel between Dover and the French coast is today the most favored scheme, but many partisans to the institution of a Channel ferry are still to be found. Among such are Sir John Pilter and M. H. J. de Cordemoy, honorary president and assistant secretary respectively of the British Chamber of Commerce in Paris. We have received from these gentlemen a paper in which they outline the salient features of their proposed scheme. As a basis of calculation they assume that an average daily transit of 4,000 tons has to be provided for. To deal with this tonnage, they say, would require the departure from each side twice every twenty four hours of a ferry capable of embarking 300 ten-ton wagons. Such a ferry, according to their estimate, would have a length of 600 feet, a breadth of 85 feet, a draught of 29½ feet, a gross tonnage of 25,000 tons and a net tonnage of 20,700. It would carry the cars on two decks above the water line and would be arranged to accommodate both goods, wagons and passenger coaches. Two such ferries would be required at a cost of £500,000 each.

A boat having a draught of 29½ feet can, according to the authors of this proposal, enter the outer port to Dover at all states of the tide. On the French coast, however, there is no port at present capable of receiving such a vessel, although it is estimated that at a cost of £1,600,000 the outer port at Boulogne could be made to give sufficient depth of water. Alternately, it is proposed to construct at an estimated cost of £3,000,000, a new deep-water port at Audressel, just south of Cape Gris Nez, and only twenty-three miles from the English coast. It is stated that the situation lends itself to the making of a deep-water port at that point, and that the construction work could be completed in about four years.

A special feature of the scheme is the provision of what the paper terms a "stockade" at each port to facilitate the movement of the wagons and coaches off or on to the ferries at any state of the tide. Details are not given as to the features of this construction. It is merely described as a metal structure of considerable size, having a fixed portion carrying lines at three levels, and a movable platform some 165 feet in length between the fixed portion and the ferry. The ferry and the stockade would be fitted with winches and cables intended to draw the wagons and coaches off or on to the ferry, and also to berth the ferry rapidly alongside the stockade. It is believed that the passenger coaches could be on the rails and moving away within twenty minutes of the arrival of the ferry at its berth, and that the 300 goods wagons could be run off within an hour. Each of the stockades is estimated to cost £400,000, so that with £1,000,000 for unforeseen expenses, the whole scheme would involve an expenditure of £5,800,000.—*The Engineer.*

Influence of the Chemical Composition and Heat Treatment of Iron Alloys on Their Magnetic Properties, Specific Resistance, and Density

The density and specific resistance of the alloys investigated containing iron with carbon, silicon, aluminium, and manganese, generally vary in a regular manner with alteration in the percentage of the added elements, so that it is possible, with good agreement with the results of direct measurement, to calculate from the figures for the alloys the corresponding values for pure iron. Irregularities in the course of the curve showing the relation between these physical properties and the composition are encountered only with alloys containing a high percentage of carbon or manganese, the latter at a proportion of 8 to 10 per cent and the former at the point at which cementite may be formed in a matrix of pearlite or martensite. Analogous irregularities are observed in the curves for coercive force and saturation value, the latter having its maximum for pure iron. The view that the addition of silicon or aluminium improves the magnetic properties of iron is therefore erroneous, this belief having arisen from the effect of these elements in reducing the oxygen content and in preventing the presence of the deleterious dissolved carbon. Aluminium and silicon also possess the technically important characteristic of increasing the specific electrical resistance and thereby reducing the tendency to eddy currents. Manganese, on the other hand, checks the separation of dissolved carbon and is, therefore, undesirable. All four ingredients cause a reduction in the true remanence of iron. Electrolytic iron after being heated and then cooled slowly, exhibits high remanence and permeability whereas after quenching the remanence and permeability are slight; on repeated heat treatment the hysteresis loops gradually become more oblique and narrower; rolled sheet iron, however, does not exhibit this behavior. Manganese and quenched carbon alloys possess several analogies; both show a simultaneous increase in the coercive force and decrease in the remanence when the percentage of the characteristic elements is raised; in order to obtain high coercive force and high remanence simultaneously it is necessary to introduce tungsten, chromium, or molybdenum. Unlike the higher manganese alloys, the carbon alloys on quenching from above 700° C. become magnetically harder than when cooled slowly.—Note in *J. Soc. Chem. Ind.* on an article by Gumlick in *Chem. Zeit.*

Electric Power in Lancashire

Data of the consumption of current in Lancashire shows a figure far in excess of the average for the whole of the country. Thus Great Britain, with its 45,000,000 population, utilizes 10,750,000 horse-power of which 2,000,000 horse-power is used by public utility undertakings. Apart from the latter proportion, therefore, the consumption of energy is of the order of 1 horsepower per five of population. In, however, an area of 400 square miles, with Manchester as its center, the population numbers 2,500,000, and in some parts of industrial Lancashire the consumption of electricity is as high as 5 horse-power per eight inhabitants, and on a somewhat lower basis of 1 horse-power to two inhabitants there would be required for the Manchester area of 400 square miles approximately 1,250,000 horse-power. The development of electrical power during the ten years from 1905 to 1915 shows an increase of 60 per cent in capital expenditure, 215 per cent in plant capacity, 190 per cent in maximum load, 300 per cent in output, 110 per cent in income, and 148 per cent in working expenses. Extensions have thus cost much less than the original plant, and larger sales at cheaper rates have resulted in a marked improvement in load factor and cost of units supplied.

The most notable increase, however, is on the power side. In 1905 the units sold for this purpose were 19,000,000, increasing to 178,000,000 in 1915, due mainly to extensions in existing industrial establishments and the starting up of new industries, and the big increase of 840 per cent may be taken as a sign of growing confidence in electrical power supplied.

Allowing for a maximum demand of 450,000 k. w. and a load factor of 50 per cent, the equivalent units amount to 2,000,000,000 per annum. The present domestic consumption of coal is about three-quarters of a ton per individual per annum, or about 2,000,000 tons. This is attended by the usual and well known loss of all valuable by-products, and very inefficient combustion and heating. Consumed in a modern power station this quantity of coal would yield the estimated 2,000,000,000 units.

The developing needs of industry will undoubtedly create a demand for bulk supply, and the cost of the supply is a factor which in turn will largely determine its use.—*London Daily Telegraph.*

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